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HP 35665A
Operator's Guide

HP 35665A Dynamic Signal Analyzer

Operator's Guide

For Instruments with Firmware Revision
A.01.00

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Guide to HP 35665A Documentation

If you are thinking about...	And you want to...	Then read...
◆ Unpack and install the HP 35665A	Install the HP 35665A Dynamic Signal Analyzer	*HP 35665A Installation and Verification Guide*
	Do operation verification or performance verification tests	*HP 35665A Installation and Verification Guide*
◆ Getting started	Make your first measurements with your new analyzer	*HP 35665A Quick Start Guide*
	Review measurement basics	*HP 35665A Concepts Guide*
	Learn what each key does	*HP 35665A Operator's Reference* or use the analyzer's **[Help]** key
◆ Making measurements	Learn how to make typical measurements with the HP 35665A	*HP 35665A Operator's Guide*
	Understand each of the analyzer's instrument modes	*HP 35665A Concepts Guide*
◆ Creating automated measurements	Learn the HP Instrument BASIC interface	*Using HP Instrument BASIC with the HP 35665A*
	Record keystrokes for a particular measurement	*HP 35665A Operator's Guide*
	Program with HP Instrument BASIC	*HP Instrument BASIC User's Handbook*
◆ Remote operation	Learn about the HP-IB	*HP–IB Programming with the HP 35665A*
	Learn how to program with HP-IB	*HP–IB Programming with the HP 35665A*
	Find specific HP-IB commands	*HP 35665A HP-IB Commands: Quick Reference*
◆ Servicing the analyzer	Adjust, troubleshoot, or repair the analyzer	*HP 35665A Service Guide*

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Chapter 1

Before You Begin

1

Before You Begin

About this Book

This book is the *HP 35665A Operator's Guide*. It shows you how to make typical measurements with the HP 35665A Dynamic Signal Analyzer. In addition, this book shows you how to perform common analysis tasks, such as building limits, using keystroke recording, and using math operations. It also shows you how to do other common tasks, such as plotting or printing your measurement results, and saving, recalling, and copying files.

This book does not show you how to use all of the analyzer's features. To learn about the analyzer's features or more general information about the analyzer, you should use the other books in this operating manual set. For more information, see "Where to find Additional Information" later in this chapter.

About the Analyzer

Introduction

The Hewlett-Packard 35665A Dynamic Signal Analyzer is a two-channel FFT spectrum/network analyzer with a frequency range that extends from nearly dc to just over 100 kHz. As such, the analyzer is a general-purpose design tool for measurement and evaluation of many electronic, electromechanical, and mechanical devices. The analyzer is also useful for noise and vibration analysis—and to make these measurements even easier, the analyzer has a built-in ICP current source for those accelerometers that require it.

Although the HP 35665A is primarily a frequency-domain analyzer, you can also use it to make time-domain and amplitude-domain measurements. To extend the analyzer's measurement capability, separate options are available for swept sine, rotating machinery, control systems, and acoustics applications.

You can also operate the analyzer remotely, via the HP-IB, to make automated measurements—a technique that's particularly useful for repetitive tasks (such as those encountered in production-line testing). However, you aren't restricted to remote operation for automated measurements—you can also use the analyzer's optional HP Instrument BASIC capability (and keystroke recording feature) to create automated measurement routines *without an external controller or computer.*

More than just a Spectrum/Network Analyzer

As we mentioned, the HP 35665A is more than just a two-channel spectrum/network analyzer. You could think of it as several instruments in a single case. When equipped with the full complement of options, the HP 35665A functions as a spectrum analyzer, network analyzer, acoustic sound level meter, acoustic intensity analyzer, vibration analyzer, digital oscilloscope, and amplitude-domain analyzer!

The standard HP 35665A has three *instrument modes*. To extend measurement capability, there are three other optional instrument modes. An instrument mode is, in effect, an individual "personality" that configures the analyzer to make specific types of measurements. For example, in FFT Analysis mode, the analyzer functions as a standard low-frequency FFT spectrum/network analyzer. In Octave Analysis mode, the analyzer functions as a real-time, parallel-filter acoustics analyzer.

The standard HP 35665A is equipped with the following instrument modes:

- FFT Analysis.
- Correlation Analysis.
- Histogram/Time.

Additionally, your HP 35665A may be equipped with the following optional instrument modes:

- Octave Analysis.
- Order Analysis.
- Swept Sine.

To learn more about instrument modes, see the *HP 35665A Concepts Guide*.

Other Options

In addition to the extended measurement capability available with the optional instrument modes, there are other options available for the HP 35665A Dynamic Signal Analyzer. These include:

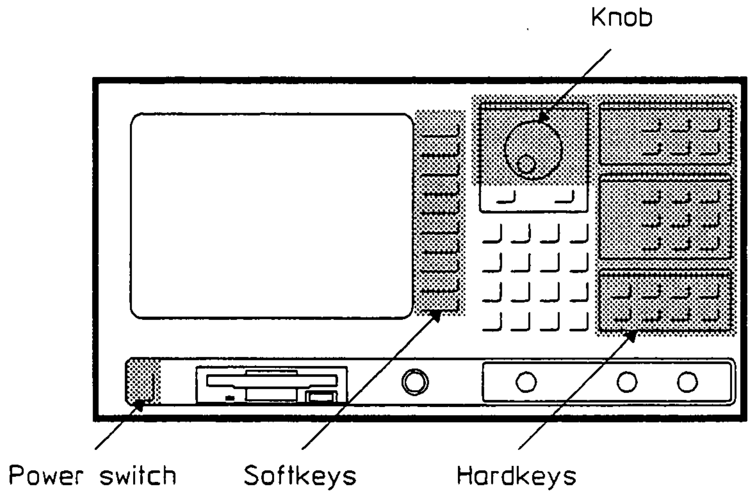
- HP Instrument BASIC
- Curve Fit/Synthesis
- External Keyboard
- Additional Memory (two or six Megabytes)
- Arbitrary Waveform Source

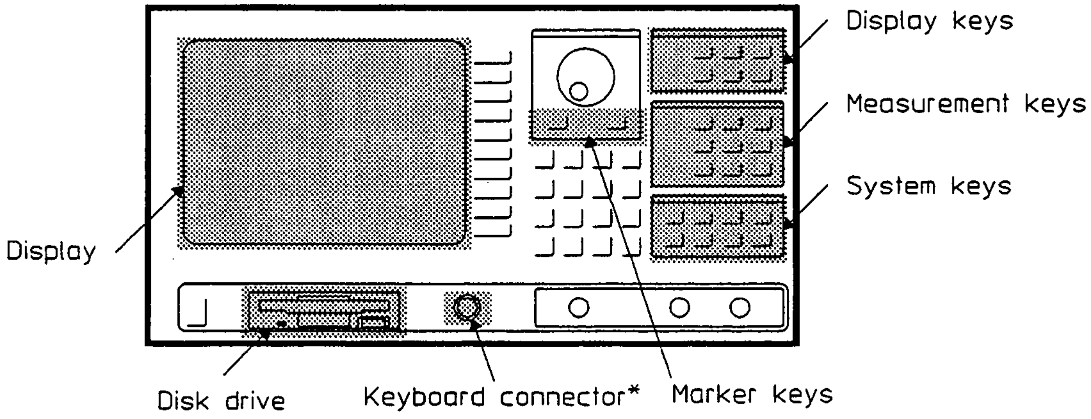
Other Options

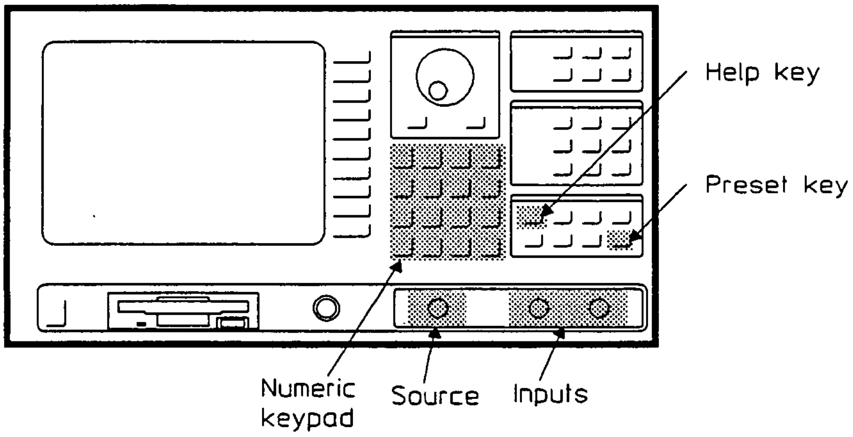
To see what options your HP 35665A analyzer has, press the [**System Utility**] hardkey and then press the [OPTIONS SETUP] softkey.

The HP 35665A at a Glance

For a detailed overview of the analyzer's front panel, see the HP 35665A Operator's Reference.


Knob
Power switch
Softkeys
Hardkeys


Display keys
Measurement keys
System keys
Display
Disk drive
Keyboard connector*
Marker keys


Help key
Preset key
Numeric keypad
Source
Inputs

* may be rear-panel mounted on some instruments

How to Use this Book

If You've Used an FFT Analyzer Before...

If you've used an FFT spectrum analyzer before, you should have no trouble making measurements with the HP 35665A. This instrument has many of the same features found in other Hewlett-Packard analyzers, such as the HP 35660A, HP 3561A, HP 3562A, HP SINE, and the HP 3566A/3567A.

For a general overview of the HP 35665A analyzer, see chapter 3 in the *HP 35665A Concepts Guide*. If you want to step though a few quick measurement tasks, use the *HP 35665A Quick Start Guide*. If you've already looked through these books, continue with the *HP 35665A Operator's Guide*.

If You Haven't Used an FFT Analyzer Before...

If you haven't used an FFT spectrum analyzer before, try one or two of the tasks in the *HP 35665A Quick Start Guide*. Then read the first part of the *HP 35665A Concepts Guide*—this contains essential background material to help you understand and use your new analyzer. In particular, be sure to review the chapters on "Spectrum Analyzer Basics" and "Getting Comfortable with the HP 35665A."

Afterwards, continue with the *HP 35665A Operator's Guide*. The sample measurements in this book are representative of many common measurements made with low-frequency spectrum analyzers. And since each task introduces the analyzer's features in a sequential, easy-to-understand fashion, you'll soon have the skills necessary to use the analyzer with total confidence. You will also find tasks that demonstrate measurements available with each of the analyzer's optional instrument modes.

Keep in mind that simply looking over the measurement tasks is not enough to really learn how to use the analyzer. If at all possible, gather the necessary equipment (outlined at the beginning of each task), set things up, and step through each measurement task. If you don't have a lot of time (or don't have the necessary equipment), make sure you have at least completed some of the tasks in the *HP 35665A Quick Start Guide.*

Firmware Revision Date

This book should be used with HP 35665A Dynamic Signal Analyzers having firmware version A.01.00. If your analyzer has a significantly different firmware revision, contact your local HP Sales/Service office to obtain a documentation set that matches your firmware revision date.

Firmware revisions are significant *only if the first two digits in the firmware revision date are changed.* For example, A.01.00 indicates a significant change from A.00.00. However, a change to A.00.01 from A.00.00 indicates very minor changes that do not affect the documentation set.

To check the firmware revision date of your instrument, press [**System Utility**] and then [**S/N VERSION**].

Need Assistance?

If you need assistance, contact your nearest Hewlett-Packard Sales and Service Office listed in the HP Catalog, or contact your nearest regional office listed at the back of this guide. If you are contacting Hewlett-Packard about a problem with your HP 35665A Dynamic Signal Analyzer, please provide the following information:

- Model number: HP 35665A
- Serial number:
- Firmware version:
- Options :
- Date the problem was first encountered:
- Circumstances in which the problem was encountered:
- Can you reproduce the problem?
- What effect does this problem have on you?

Notation Conventions

Hardkeys

Throughout this book, they are printed like this: [**Inst Mode**]. Hardkeys are front-panel buttons whose functions are always the same. Hardkeys have a label printed directly on the key itself.

Softkeys

Throughout this book, softkeys are printed like this: [FFT ANALYSIS]. Softkeys are keys whose functions change with the analyzer's current menu selection. A softkey's function is indicated by a video label to the left of the key (at the edge of the analyzer's screen).

Toggle Keys

Some keys toggle through different settings. Toggle softkeys have a highlighted word in their label that changes with each press of the softkey. Throughout this book, toggle softkeys are depicted as they *appear after you make the keypress.* For example, "toggle to [X-AXIS **LIN** LOG]" means to press [X-AXIS LIN/LOG] until the word LIN is highlighted.

There is only one toggle hardkey. This is the [**Pause-Cont**] hardkey.

Ghosted Softkeys

Occasionally, a softkey may be inactive—this occurs when a softkey is not appropriate for a particular measurement. When this happens, the analyzer "ghosts" the inactive softkey. For example, if you set the analyzer to one-channel mode, and then press [**Meas Data**], the [FREQUENCY RESPONSE] softkey will be ghosted. This is because frequency response measurements are only possible when the analyzer is in two-channel mode.

Where to find Additional Information

Using the [**Help**] key

The [**Help**] key on the analyzer's front panel provides fast, easy-to-read information about specific instrument controls and features. Using [**Help**] is particularly convenient when you need assistance and you don't have the *Operator's Reference* near at hand.

The [**Help**] key is also a good way to learn about the analyzer (or to refresh your memory if you don't use the analyzer very often). The help facility also has an index that lets you request information by key name or by topic.

The Quick Start Guide

Use the *HP 35665A Quick Start Guide* as an introduction to the HP 35665A. If you haven't read this book yet, you should probably do so. The Quick Start Guide is very short, but it's designed to get you comfortable with the analyzer by helping you make a sample measurement within fifteen minutes.

The Concepts Guide

For a conceptual overview of the analyzer and in-depth discussion of the analyzer's major features, use the *HP 35665A Concepts Guide*. Where appropriate, the *Concepts Guide* includes sample tasks to help you get comfortable with some of these features.

The *Concepts Guide* also contains essential background material to help you understand and use the HP 35665A. This is particularly useful if you haven't used a spectrum/network analyzer before, or if you haven't used an FFT analyzer before. It may also be useful if you just want to review some basic measurement concepts.

The Operator's Reference

For random-access information about the analyzer's controls and features, refer to the *HP 35665A Operator's Reference*. This is a dictionary-style reference that offers introductory tours of both front and rear panels, menu maps, and a short description of each hardkey and softkey.

Programmer's Reference

To help you operate the analyzer remotely via HP-IB, see *HP-IB Programming with the HP 35665A*. Here you'll find a conceptual overview of the HP-IB and how you can use it to control you instrument remotely. There is also a command reference that lists all HP-IB commands specific to the HP 35665A. This includes a description of each command, its proper syntax, and example statements. Additionally, there are sample programs to help you create your own HP-IB programs.

HP Instrument BASIC

To learn more about using HP Instrument BASIC (a subset of the HP BASIC programming language) with your new analyzer, see *Using HP Instrument BASIC with the HP 35665A*. This shows you how to record and develop programs for the HP 35665A. There are also sample programs to help you get started with HP Instrument BASIC.

For more global information about HP Instrument BASIC, see the *HP Instrument BASIC User's Handbook*. This is a generic handbook for the HP Instrument BASIC language.

Installation and Verification Test Guide.

For specifications, installation instructions, and performance tests, see the *HP 35665A Installation and Verification Guide*.

Service Guide

For service information, see the *HP 35665A Service Guide*. This manual includes adjustments, replaceable parts, circuit descriptions, and troubleshooting.

Demonstration Disc

Consider ordering the *HP Dynamic Signals Demo Disc* (HP part number 35665-95900). This contains captured signals from microphones and vibration transducers for 72 different types of signals. These may be helpful as you learn to use the HP 35665A Dynamic Signal Analyzer—particularly if you are interested in making acoustics or vibration measurements.

To use the demonstration disc, you simply connect a standard audio Compact Disc player to the analyzer's input connectors. Each disk is shipped with documentation to explain the signals and to offer appropriate measurement suggestions. For more information, contact your local Hewlett-Packard Sales and Service Office.

Related Information.

Additionally, you will find applications information in numerous Hewlett-Packard application notes. These are available from your local HP Sales and Service Office.

Using the Optional Keyboard...

The HP 35665A analyzer has a connector that lets you attach an optional alphanumeric keyboard. You can use the keyboard to perform the same functions as you would using the front-panel alpha keys—for example, when specifying filenames or when entering a trace title. And using the keyboard makes it much easier to edit HP Instrument BASIC programs.

It's important to know that the keyboard remains active *even when the analyzer is not in alpha entry mode*. This means that you can operate the analyzer using the external keyboard rather than the front panel. Pressing the appropriate keyboard key does the same thing as pressing a hardkey or a softkey on the analyzer's front panel.

Caution

Use only the approved keyboard for this product. Hewlett-Packard does not warrant damage or performance loss caused by a non-HP approved keyboard. Currently, approved Hewlett-Packard keyboards are as follows:

- U.S. ASCII (C1405A #ABA)
- U.K. English (C1405A #ABU)
- German (C1405A #ABD)
- French (C1405A #ABF)
- Italian (C1405A #ABZ)
- Spanish (C1405A #ABE)
- Swedish/Finnish (C1405A #ABS)

Note

In addition to the U.S. English keyboard, the HP 35665A Dynamic Signal Analyzer supports French, German, Italian, Spanish, U.K./English, and Swedish/Finnish keyboards. To configure your analyzer for a keyboard other than U.S. English, press [**System Utility**] [KEYBOARD SETUP]. Then press the appropriate softkey to select the language.

Configuring your analyzer to use a different keyboard only ensures that the analyzer recognizes the proper keys for that particular keyboard. Configuring your analyzer to use another keyboard *does not* localize the on-screen annotation or the analyzer's online HELP facility.

To learn more about the optional keyboard, see the *HP 35665A Operator's Reference*.

Chapter 2

Source Characterization

Source Characterization

Task Overview

This task is similar to the one presented in chapter 2 of the HP 35665A Quick Start Guide. However, the task here introduces vector averaging. It also shows you how to specify a trace title.

This task shows you how to look at a sine signal source (either from the analyzer's sine source or from an external signal generator), measure its frequency, and measure its harmonic distortion. You will be using the analyzer's FFT Analysis mode.

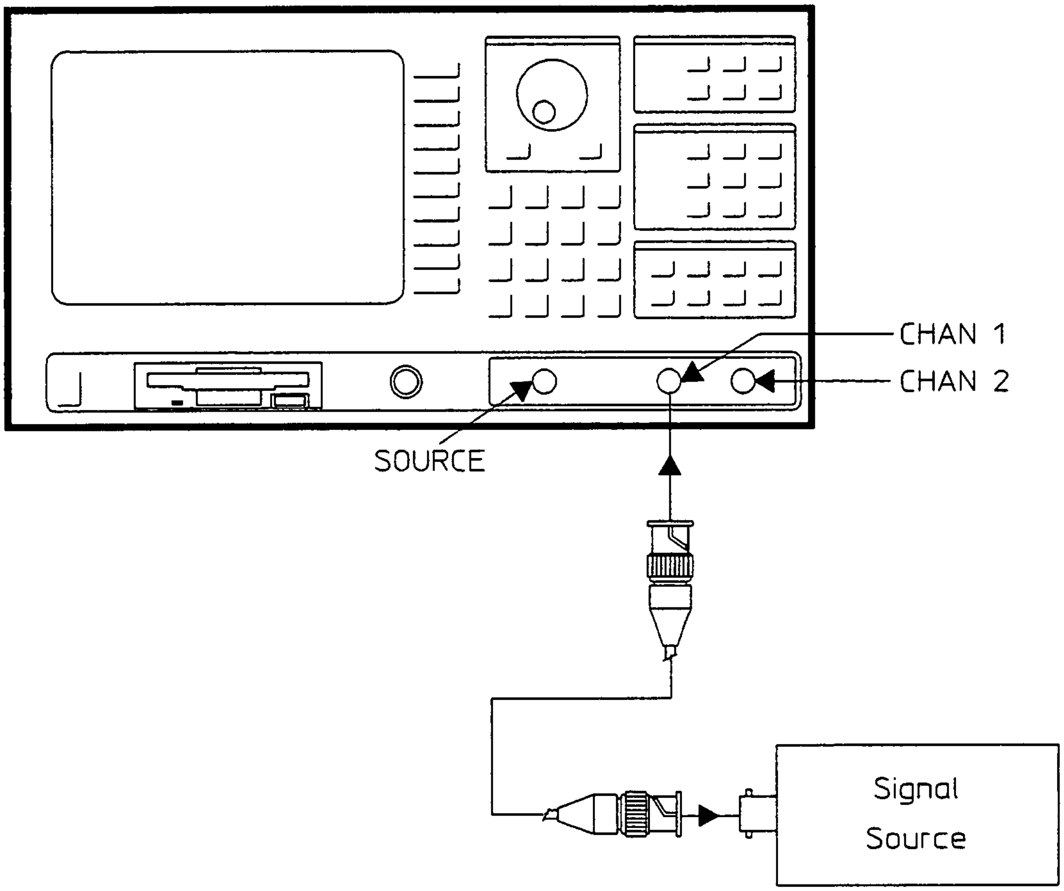
What you will need:

- One connecting cable, 12 inches (30 cm) or longer; this should be a BNC male to BNC male.
- Signal source (you can use the analyzer's own source if you'd like).
- If necessary, an appropriate feedthrough terminator for your source (not needed if you're using the analyer's internal source).

What you will do:

- Look at a 10 kHz signal.
- Measure the frequency and amplitude of the fundamental.
- Look for the second harmonic of the fundamental frequency, and measure its amplitude.
- Learn how to use the relative marker.
- Learn how to use the analyzer's harmonic distortion marker function.
- View the difference between rms averaging and vector averaging.
- Create a title for the displayed trace.

Task Setup


CHAN 1
CHAN 2
SOURCE
Signal
Source

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. If the analyzer is turned off, turn it on.

   Then press [**Preset**].

   Now press [DO PRESET].

Presetting returns most of the analyzer settings to their default positions.

2. If you're using an external signal source, connect its output to the analyzer's channel 1 input, as shown in the task setup illustration. *Then go to step 4.*

For this task, we used the analyzer's internal sine source.

The HP 35665A analyzer has an input impedance of approximately 1 Megohm, If your external signal generator is designed to operate into a lower impedance, use a feedthrough terminator between the signal generator and the HP 35665A's input.

3. Press [**Source**].

   Now toggle to [SOURCE **ON** OFF].

   Skip this step if you're using an external signal source.

This turns on the analyzer's source. The default source is a 10.24 kHz sine signal. However, the signal is not yet visible because its default output level is 0 volts.

If you are using an external signal generator, configure it to produce a sine wave at approximately 10 kHz.

4. Press [LEVEL].

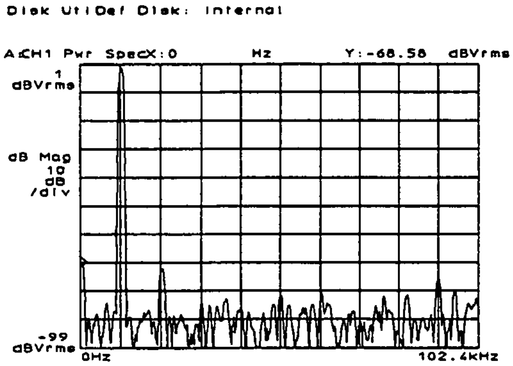
   Now press [0] and then press [dBVrms].

   If you are using an external signal source, set the level to 0 dBVrms (1 Vrms).

This sets the sine source as close as possible to 0 dBVrms (1 Vrms). Entering a numeric value is a two-step process—first you enter the number with the numeric keypad, then you press a softkey to specify an appropriate unit suffix.

5. Now look at the analyzer's screen. You should see the fundamental and at least one harmonic.

The default frequency span is 0 Hz to 102.4 kHz. The 10.24 kHz test signal thus appears at the left of the analyzer's display.



6. Press [**Avg**].

   Toggle to [AVERAGE **ON** OFF].

This turns on averaging. The default number of averages is ten.

7. Press [**Start**].

Note how another averaged measurement begins.

8. Press [**Marker**] and

   press [MARKER TO PEAK].

This brings up the marker menu and then moves the marker to the largest frequency component on the display—in this case, the 10 kHz fundamental.

The X-axis marker readout (at the top of the screen) verifies that this frequency is 10.24 kHz. The Y-axis marker readout shows that the amplitude of this component is 0 dBV.

The marker you are using is the *absolute marker*. It indicates the absolute x-axis and y-axis coordinate of the current marker position. There's also a *relative marker*—but you'll learn about that in a few moments.

9. Press [NEXT PEAK RIGHT].

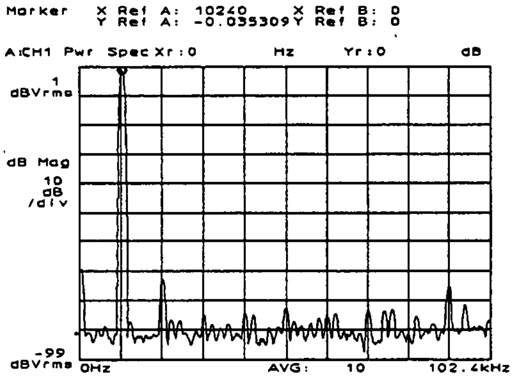
This moves the marker to the next largest frequency component on the display to the right of the previous marker position. In this case, the location should be around 20 kHz, which is the second harmonic.

Alternatively, you could use turn the knob to move the marker to the second harmonic. The knob is also useful when entering numeric values, as we'll discover later. Note the amplitude value indicated by the marker's Y-axis position. This value is about – 72 dBVrms. Since the fundamental is about 0 dBVrms, the second harmonic is about 72 dB below the fundamental.

10. Press [MARKER TO PEAK] and

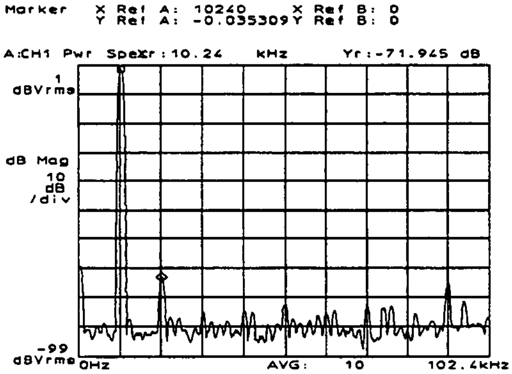
    press [REFERENCE TO MARKER].

    This turns on the relative marker and zeroes it at the marker current marker position. Both X and Y marker readouts are now set to zero—this point now becomes the reference.


Marker
X Ref A: 10240
Y Ref A: -0.035309
X Ref B: 0
Y Ref B: 0
A:CH1 Pwr Spec Xr : 0 Hz
Yr : 0 dB
1 dBVrms
dB Mag
10 dB /div
-99 dBVrms
0Hz
AVG: 10
102.4kHz

11. Press [NEXT PEAK RIGHT].

    Note how the Y-axis marker readout indicates a relative reading of approximately -72 dB, and the X-axis marker readouts are now set to zero—this point now becomes the reference.


Marker
X Ref A: 10240
Y Ref A: -0.035309
X Ref B: 0
Y Ref B: 0
A:CH1 Pwr SpeXr : 10.24 kHz
Yr : -71.945 dB
1 dBVrms
dB Mag
10 dB /div
-99 dBVrms
0Hz
AVG: 10
102.4kHz

12. Press [MARKER TO PEAK] and

    toggle to [MKR VALUE **ABS** REL].

    This moves the marker back to the fundamental and turns off the relative marker.

13. Press [**Marker Function**],

press [HARMONIC],

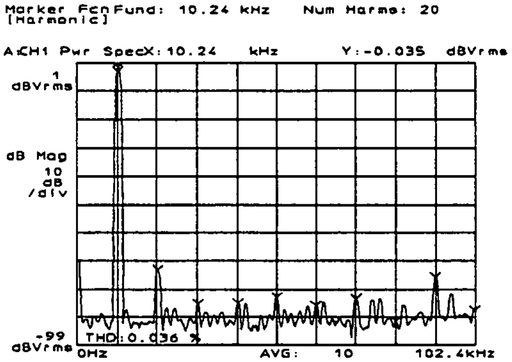
press [FUNDAMNTL FREQUENCY].

This turns on the harmonic distortion marker and sets the fundamental frequency to equal the current marker position—in this case, 10.24 kHz.

Press [**Marker Value**]. This hardkey is located in the numeric keypad.

Then press [THD].

Pressing [THD] displays the results of the THD calculation. The results appear at the bottom of the analyzer's display. In the example here, the THD should be about 0.03 percent.



14. Press [**Avg**],

press [AVERAGE TYPE],

press [VECTOR].

This selects vector averaging. Vector averaging reduces but does not affect synchronous signals. In a moment, we'll see how vector averaging lowers the noise floor to reveal more clearly harmonics of the test signal.

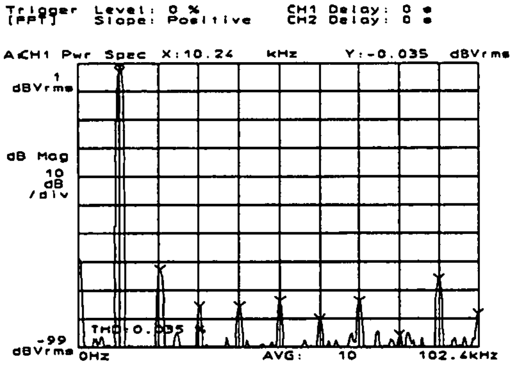
15. Press [**Trigger**] and

    press [CHANNEL 1 TRIGGER].

For vector averaging to be effective, you must synchronize the analyzer's trigger to the input signal. That's why we selected [CHANNEL 1 TRIGGER].

16. Press [**Start**].

This begins a new measurement. Notice how the noise floor lowers and how much easier it is to view harmonics of the sine signal.



17. Press [**Disp Format**],

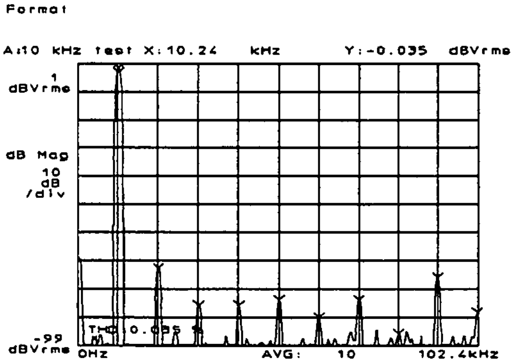
    press [MORE],

    press [TRACE TITLE].

In a moment, we'll select a trace title.

18. Then use the knob, the numeric-entry keys, and the alpha-shifted hardkeys to enter a name for the stored trace (alternatively, you can use the optional keyboard).

    Then press [ENTER].



In the example here, we selected "10 kHz test" as the trace title.

When the analyzer prompts you for a name—a trace title, for example—it automatically switches to alpha entry mode. In alpha entry mode, the analyzer shifts certain hardkeys to alpha entry keys (note the alpha characters engraved on the front panel below these hardkeys). You can also specify uppercase or lowercase letters, using the [UPPERCASE LOWERCASE] softkey.

If you make a mistake, you can use the appropriate edit softkeys to fix the title. You can also use the knob to help you edit. If you have the optional keyboard, you can enter trace titles more easily.

To use the default trace title, simply toggle to [DFLT TITL **ON** OFF].

Chapter 3

Device Characterization

3

Device Characterization

Task Overview

This task is similar to the one presented in chapter 3 of the HP 35665A Quick Start Guide. However, the task here uses an external device-under-test. In addition, it also shows how to store measurement results.

This task shows how to use the analyzer's FFT Analysis mode to make a typical network measurement. You can use any appropriate device-under-test—for example, a filter. In this example here, we used a 5 kHz low-pass filter.

What you will need:

- Three connecting cables, 12 inches (30 cm) or longer. These should be BNC male to BNC male cables.
- One BNC "T" adapter.
- A device-under-test, such as a filter. In the example here, we used a 5 kHz low-pass filter.

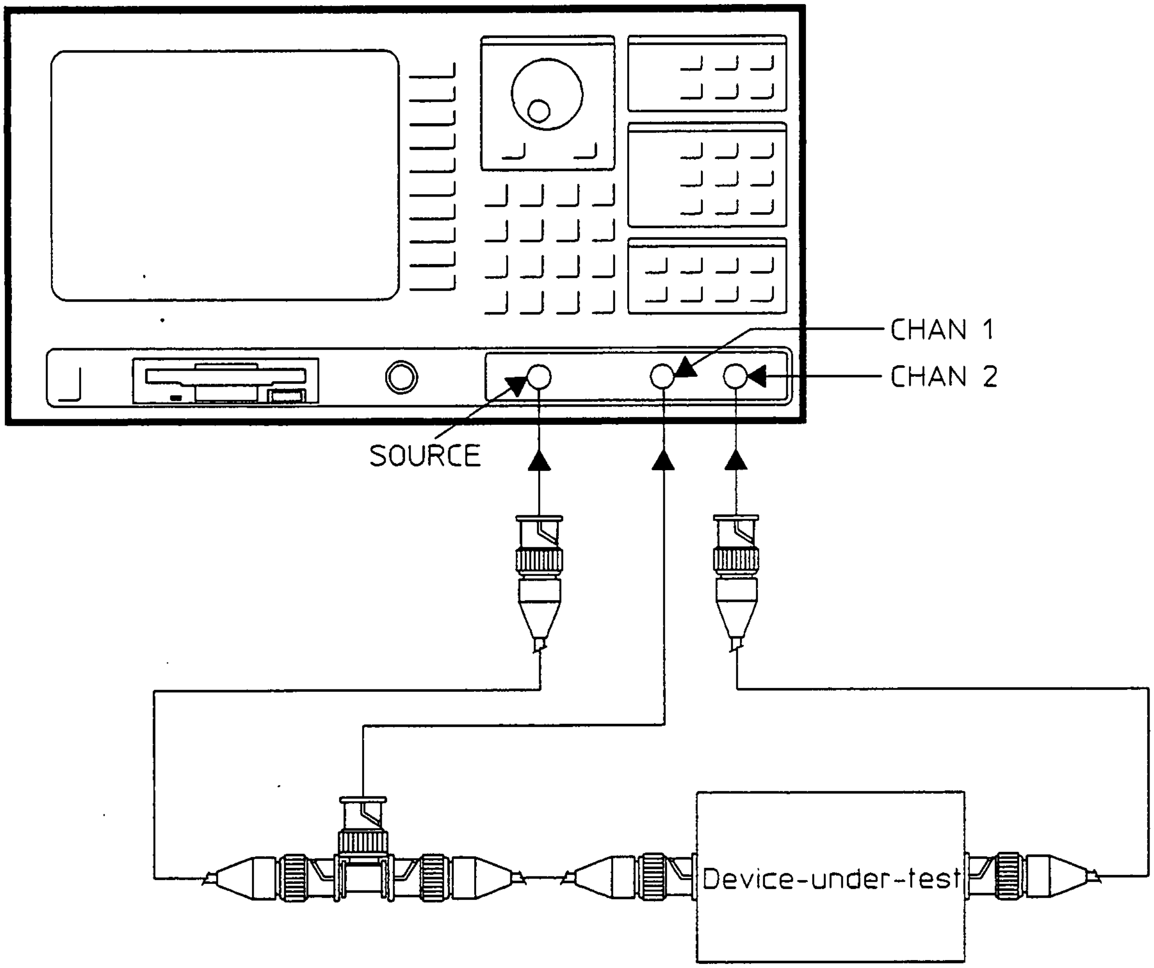
What you will do:

- Look at the frequency response and phase of a device-under-test.
- Find the peak of the frequency response.
- Measure the gain at the peak response.

What you will learn:

- How to select a different trace coordinate.
- How to use active entry.
- How to save the measurement results to a data register.

Task Setup


CHAN 1
CHAN 2
SOURCE
Device-under-test

The Task

As you step through the following task, your measurement results will be different than those shown here, since your device-under-test may be different from the one used in this sample task. Keep in mind that these tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. If the analyzer is turned off, turn it on.

   Then press [**Preset**].

   Now press [DO PRESET].

Pressing [**Preset**] returns most of the analyzer settings to their default positions.

2. Connect the analyzer's source to both the channel 1 input and to the input of your device-under-test. Then connect the output of your device-under-test to the channel 2 inputs. See the task setup illustration.

The HP 35665A analyzer has an input impedance of approximately 1 Megohm. If your device-under-test needs to be terminated with a lower impedance, use an appropriate feedthrough terminator between the output of the device-under-test and the channel 2 input.

The analyzer's source impedance is very low (less than 5 ohms) and is designed to be operated into nearly any type of load. If your device-under-test required a specific source impedance, be sure to place an appropriate resistor in series with the analyzer's source output. For example, if your device-under-test requires a source impedance of approximately 600 ohms, you can insert a 590 ohm resistor in series with the analyzer's source output.

3. Press [**Inst Mode**] and

   press [2 CHANNEL].

This configures the analyzer to make two channel measurements. Network measurements, such as device characterization, can only be made in two channel mode.

4. Press [**Meas Data**] and

   press [FREQUENCY RESPONSE].

This sets the display to show the frequency response trace for the current measurement.

5. Press [**Source**].

   [RANDOM NOISE]

   Now toggle to [SOURCE **ON** OFF].

This turns on the analyzer's source and selects a random noise waveform.

The random noise signal is not yet visible because its default output level is 0 volts.

For some devices, you may get better results if you use other types of source waveforms. Burst waveforms are particularly effective for characterizing devices more quickly than with random noise—however, burst waveforms require you to use triggering and to use different window selections. See the *HP 35665A Concepts Guide* and the *HP 35665A Operator's Reference* to learn more about these topics.

6. Press [LEVEL].

   Use the numeric entry hardkeys to enter "1." Then press [Vrms].

   Use a lower voltage if your device-under-test will be damaged with a 1 Vrms input.

This sets the noise waveform to 1 Vrms.

It isn't always necessary to first press a softkey before making a numeric entry. A highlighted softkey is the softkey that is currently dedicated to the numeric keypad. This is called *active entry*.

For example, notice how the [LEVEL] was already highlighted. Pressing any of the numeric keypad keys automatically brings up a numeric entry window for setting the level. You did not have to press [LEVEL] to set the source level.

7. Press [**Avg**].

   Toggle to [AVERAGE **ON** OFF].

This turns on averaging. The default number of averages is ten. That's fine for this example.

8. Press [**Scale**] and toggle to

   [AUTOSCALE **ON** OFF].

This turns on autoscaling.

Autoscaling means the analyzer automatically selects an appropriate scale for the currently displayed trace.

9. Press [**Start**].

Note how another averaged measurement begins.

10. In our example, a frequency span of 0 Hz to 51.2 kHz is adequate.

    If you want to examine your device-under-test with a different frequency range, press [**Freq**] and use the [SPAN] and [CENTER] softkeys, or the [START] and [STOP] softkeys to change the frequency range of your measurement.

To specify a frequency span, you can specify a center frequency and a span. Alternatively, you can simply specify a start and a stop frequency.

The analyzer's maximum frequency range in two-channel mode is 51.2 kHz. You must be in two-channel mode to make frequency response measurements.

11. Press [**Marker**] and

press [MARKER TO PEAK].

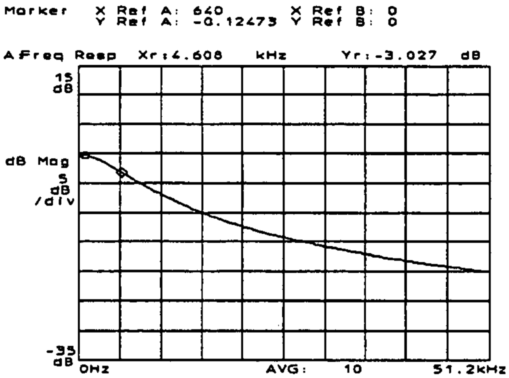
This moves the marker to the largest part of the frequency response trace. Because we are looking at a frequency response trace, the X-marker indicates amplitude in relative terms (dB).

Press [REFERENCE TO MARKER] and move the relative marker with the knob until you find the 3 dB point of the filter. If you're using a bandpass filter, you can move the marker to find both 3 dB points.

In the example here, our low-pass filter has its 3 dB point at approximately 5 kHz.

Practice toggling between [MKR VALUE ABS **REL**] and [MKR VALUE **ABS** REL] to see how you can use both the absolute and relative markers to examine the response of your device-under-test.

As you move the *relative* marker, you can view the relative gain/loss of your particular device-under-test at different frequencies. To view the absolute gain/loss of your device-under-test, you can change back to the *absolute* marker (we explained the difference between these two markers back in chapter 2).

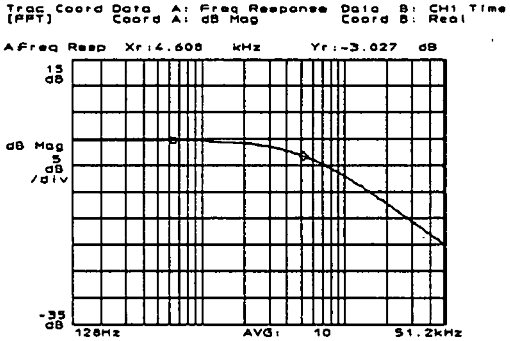


12. Press [**Trace Coord**] and

toggle to [X-AXIS LIN **LOG**].

If you don't want to view your measurements results on a log X-axis, skip this step.

This displays the measurement data on a logarithmic scale. This is more useful for viewing the frequency response of some devices, particularly audio-frequency devices.



As you move the marker with the knob, notice how the distance between each frequency resolution point is less as you move toward the right-hand side of the display. It's important to remember that although you are displaying the frequency response data with a logarithmic X-axis, the individual data points that make up the frequency response trace are still spaced in a linear fashion.

To make a frequency response measurement with true logarithmic resolution, you can use the analyzer's Swept Sine mode with logarthmic sweep. We'll show you how to do that in the next chapter.

13. Press [**Disp Format**] and

press [UPPER/LOWER].

This selects the upper/lower display format.

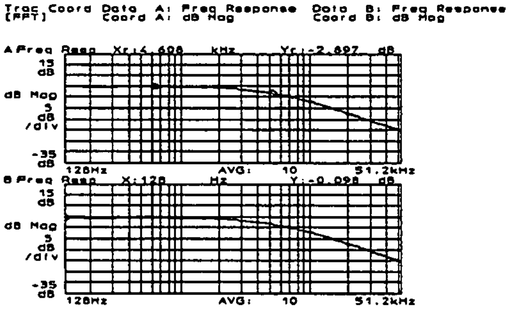
Now press [**Active Trace**].

This specifies the lower trace as the active trace.

Press [**Meas Data**] and

press [FREQUENCY RESPONSE].

This puts the frequency response trace on the lower trace. In a moment, we'll look at phase information for this frequency response trace.



Keep in mind that only one trace is "active" at any given time (this is indicated by the highlighted trace title). The active trace is the target of any adjustments you make with the cluster of hardkeys under the **DISPLAY** group. To learn more about these hardkey groups (and other front-panel concepts) see the *HP 35665A Operator's Reference*.

14. Press [**Trace Coord**].

In a moment, we're going to change the lower trace from dB magnitude trace coordinate to the phase coordinates.

15. If the upper trace is displayed on a log X-axis, toggle to [X-AXIS LIN **LOG**].

    If you don't want to view your measurements results on a log X-axis, skip this step.

16. Press [PHASE].

This changes the trace coordinate from dB magnitude to phase.

Now press [**Scale**] and toggle to [AUTOSCALE **ON** OFF].

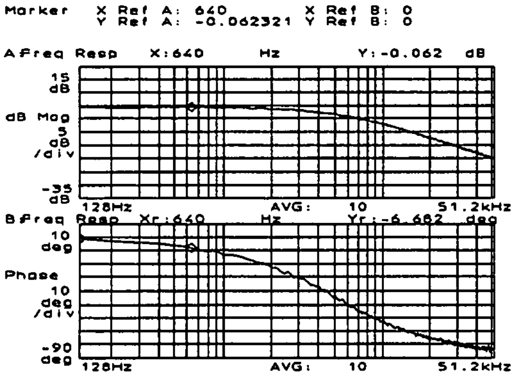
Autoscaling is often required to get a better view of the phase response.

17. Press [**Marker**] and

    toggle to [COUPLED **ON** OFF].

Marker coupling means that markers for both the upper and lower trace move at the same time when you turn the knob.

By the way, marker coupling does *not* convert both markers to absolute or to relative operation if one marker is set to relative and the other to absolute. You'll have to use the [**Active Trace**] hardkey to select the appropriate trace before toggling between the relative and the absolute marker.


Marker X Ref A: 640 X Ref B: 0
Y Ref A: -0.062321 Y Ref B: 0
AFreq Resp X:640 Hz Y:-0.062 dB
15 dB
dB Mag
5 dB /div
-35 dB
128Hz AVG: 10 51.2kHz
BFreq Resp Xr:640 Hz Yr:-6.682 deg
10 deg
Phase
10 deg /div
-90 deg
128Hz AVG: 10 51.2kHz

18. Press [**Save/Recall**],

    press [SAVE DATA],

    press [SAVE TRACE],

    press [INTO D1].

This saves the frequency response trace into data register D1. That way, you can recall this measurement data to compare it with subsequent measurements. If you don't save a trace, you lose this data when you start another measurement.

Data registers are used for intermediate storage of data—their contents are lost when you turn off the analyzer's power. You can also save a trace directly to the analyzer's non-volatile RAM disk, volatile RAM disk, or internal disk. To learn more about saving and recalling traces, see chapter 11.

19. Press [**Meas Data**],

    press [MORE],

    press [DATA REGISTER],

    press [D1].

You are now looking at the frequency response trace as recalled from data register D1.

If the data is displayed on a linear X-axis, press [**Trace Coord**] and toggle to [X-AXIS LIN **LOG**] to convert to a logarithmic X-axis.

20. If you are going to turn off the analyzer—but you want to save this trace—you must save the frequency response trace to the analyzer's non-volatile RAM disk or to the internal disk.

If you want to save the trace to the analyzer's internal disk, you need to insert a formatted 3.5-inch flexible disk into the analyzer's internal disk drive.

To learn how to format a disk, see chapter 11.

21. Press [**Save/Recall**],

    press [DEFAULT DISK],

    press [NON-VOL RAM DISK],

    press [RETURN].

This selects the non-volatile RAM disk as the mass storage device.

22. Press [SAVE DATA],

    press [SAVE TRACE],

    press [INTO FILE].

    Then use the alphanumeric keys (or optional keyboard) to specify a filename.

You can use any name—for example, "TRACE1."

23. Press [**Save/Recall**],

    press [RECALL DATA],

    press [RECALL TRACE],

    press [FROM FILE INTO D1],

    press [ENTER].

This copies the file "TRACE1" from the analyzer's non-volatile RAM disk to data register D1.

When you pressed [FROM FILE INTO D1], the analyzer prompted you with the filename "TRACE1." This is because "TRACE1" was the last file that you saved. You could have used the alpha-shift keys and the numeric keypad (or the optional keyboard) to specify a different file.

Again, you may have to press [**Trace Coord**] and toggle to [X-AXIS LIN **LOG**] to convert to a logarithmic X-axis.

Chapter 4

Device Characterization with Swept Sine mode

4

Device Characterization with Swept Sine mode

Swept Sine measurements are available only with those HP 35665A analyzers that are equipped with Option 1D12. To see what options your HP 35665A analyzer has, press the [**System Utility**] *hardkey and then press the* [OPTIONS SETUP] *softkey.*

Task Overview

This task shows you how to use the analyzer's Swept Sine mode to make a typical network measurement, and is similar to the one presented in chapter 4 of the *HP 35665A Quick Start Guide.* The task here, however, introduces some additional features of Swept Sine mode.

This task is nearly identical to the task in the previous chapter *except that you will be characterizing a device with a swept sine signal rather than a random noise waveform.* To learn about the analyzer's Swept Sine mode—and why it's useful for some measurements—see the *HP 35665A Concepts Guide.*

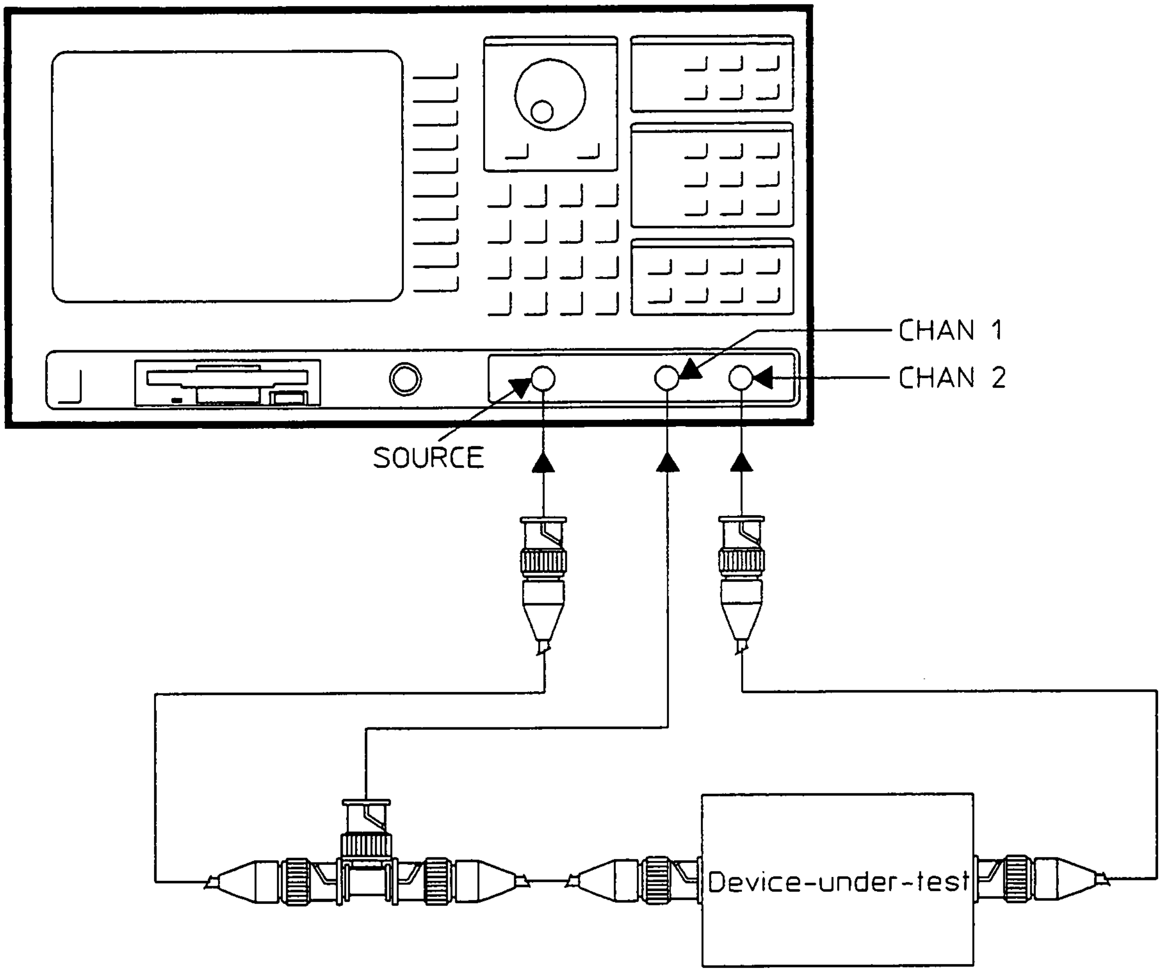
What you will need:

- Three connecting cables, 12 inches (30 cm) or longer. These should be BNC male to BNC male cables. If you want to characterize an external device, you will need three cables.
- One BNC "T" adapter.
- A device-under-test, such as a bandpass filter.

What you will do:

- Look at the frequency response of a device-under-test.
- Examine the effects of changing frequency resolution in the Swept Sine mode
- Learning how to use autoresolution

Task Setup


CHAN 1
CHAN 2
SOURCE
Device-under-test

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. If the analyzer is turned off, turn it on.

   Then press [**Preset**].

   Now press [DO PRESET].

   Presetting returns most of the analyzer settings to their default positions.

2. Connect the analyzer's source to both the channel 1 input and to the input of your device-under-test. Then connect the output of your device-under-test to the channel 2 inputs. See the task setup illustration.

   The HP 35665A analyzer has an input impedance of approximately 1 Megohm. If your device-under-test needs to be terminated with a lower impedance, use an appropriate feedthrough terminator between the output of the device-under-test and the channel 2 input.

   The analyzer's source impedance is very low (less than 5 ohms) and is designed to be operated into nearly any type of load. If your device-under-test required a specific source impedance, be sure to place an appropriate resistor in series with the analyzer's source output. For example, if your device-under-test requires a source impedance of approximately 600 ohms, you can insert a 590 ohm resistor in series with the analyzer's source output.

3. Press [**Inst Mode**]

   [SWEPT SINE].

   This configures the analyzer to make swept sine measurements. Notice how the [1 CHANNEL] softkey is ghosted—this is because the analyzer operates only in 2 channel mode when making swept sine measurements.

5. Press [**Source**].

   [LEVEL].

   Using the numeric entry hardkeys, enter "1." Then press [Vrms].

   This sets the sine source to 1 Vrms.

   Use a lower voltage if your device-under-test will be damaged with a 1 Vrms input.

6. Press [**Freq**].

   Toggle to [SWEEP LIN **LOG**].

   This selects a logarithmic sweep. This is useful for characterizing the swept response of an audio-frequency device.

   If you don't want to use a logarthmic sweep, skip this step.

   When you select a logarithmic sweep, the analyzer automatically switches to a logarithmic X-axis when you press [**Start**].

7. Press [**Start**].

   This starts the swept sine measurement. Notice how the analyzer automatically changed to a logarithmic X-axis.

   If you wanted to use a linear X-axis for a log sweep, you'd have to press [**Trace Coord**] and toggle to [X-AXIS LIN **LOG**].

8. In our example, a 50 kHz frequency span is adequate.

   If you want to examine your device-under-test with a different frequency range, press [**Freq**] and use the [SPAN] and [CENTER] softkeys, or the [START] and [STOP] softkeys to change the frequency range of your measurement.

   To specify a frequency span, you can specify a center frequency and a span. Alternatively, you can simply specify a start and a stop frequency.

   The analyzer's maximum frequency range in Swept Sine mode is the same as it is in any two-channel mode—51.2 kHz.

9. If you've changed the frequency span, press [**Start**] again.

This starts the measurement using the newly-specified frequency range.

10. Press [**Scale**] and toggle to [AUTOSCALE **ON** OFF].

This turns on autoscaling.

Autoscaling means the analyzer automatically selects an appropriate scale for the currently displayed trace.

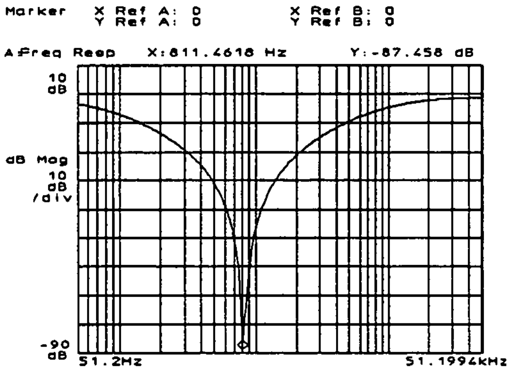
11. Using the knob, move the marker to examine the frequency response of your device-under-test.

In our example, we tested a notch filter. Our swept sine frequency response trace revealed a deep null (–87 dB) at appoximately 8 kHz.

As you move the marker with the knob, notice how the distance between each frequency resolution point the same no matter where you move the marker. This is because you used a logarithmic sweep to make this measurement.

If you want to search for the peak, press [**Marker**] and press [MARKER TO PEAK].

You may also want to toggle between absolute and relative markers.



12. Press [**Freq**],

    press [RESOLUTION SETUP],

    press [RESOLUTION].

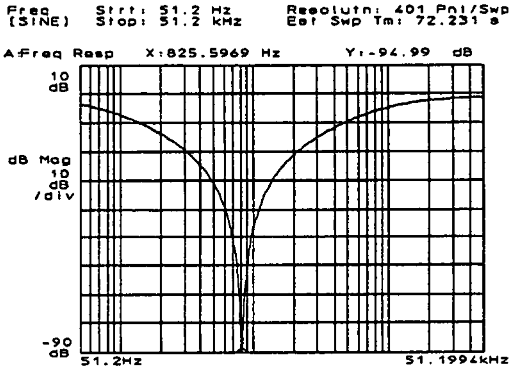
    Then enter 401 with the numeric keypad and use the "points / sweep" suffix.

This specifies a swept measurement with 401 points—the maximum number of points available is 801 per sweep. The more points you specify, the slower the measurement will be, but you'll get better resolution.

In another few steps, we'll show you how to use *autoresolution*. This is a feature that lets you speed up high-resolution swept sine measurements.

13. Press [**Start**].

    Note how this measurement takes longer, since it takes measurement data for 401 points, not 101 points (the default value).



For your convenience, the analyzer shows the estimated sweep time at the top right-hand corner of the screen.

In our example, the increased resolution shows that the null is deeper than we thought. We can see that the null is really about –95 dB. Swept sine measurements are particularly good for testing devices that require a wide dynamic range to characterize correctly, such as the notch filter used in our example.

14. Press [**Freq**],

    press [RESOLUTION SETUP],

    and toggle to [AUTORES **ON** OFF].

    Then press [**Start**].

Notice how the measurement was made much faster.

When autoresolution is off, the frequency spacing between measurement points is determined by the sweep resolution and does not change during a sweep.

When autoresolution is on, the analyzer adjusts the frequency spacing between measurement points (providing finer or coarser resolution steps) to accommodate varying response changes. This allows you to make faster measurements without missing critical information.

By the way, the estimated sweep time does not change when you switch to autoresolution, since the analyzer cannot estimate the time savings for an autoresolution measurement (this time varies, depending on the slope of the frequency response trace).

15. Press [RETURN],

    and toggle to [SWEEP AUTO **MAN**].

    Then press [MANUAL FREQ] and

    enter "1 kHz" with the numeric keypad.

    Now press [**Start**].

    While using manual sweep, you can use the knob to change the manual frequency.

This sets the output of the swept sine source to 1 kHz. The analyzer's display shows the response of your device-under-test only at 1 kHz.

When you toggle from automatic sweep to manual sweep while an automatic sweep is in progress, the analyzer sets the manual frequency equal to the most recent frequency in use when you toggled to manual sweep.

Setting a manual frequency is particularly useful when you need a steady tone to set up your device-under-test—for example, when calibrating it to a certain input level.

Do not confuse the [SWEEP AUTO **MAN**] softkey with the [AUTO RES ON **OFF**] softkey.

Chapter 5

Measuring Acoustic Noise

5

Measuring Acoustic Noise

Octave measurements are available only with those HP 35665A analyzers that are equipped with Option 1D1. To see what options your HP 35665A analyzer has, press the [**System Utility**] *hardkey and then press the* [OPTIONS SETUP] *softkey.*

Task Overview

This task shows how to make a simple acoustic noise measurement using the HP 35665A's Octave Analysis mode. Although the noise signal used here was obtained from the *HP Dynamic Signals Compact Disc* (HP part number 35665-84401), you can obtain similar signals using a calibrated microphone and a comparable noise source.

This task demonstrates only some of the capabilities of the analyzer's Octave Analysis mode. You can find additional information about Octave Analysis mode in the *HP 35665A Concepts Guide.*

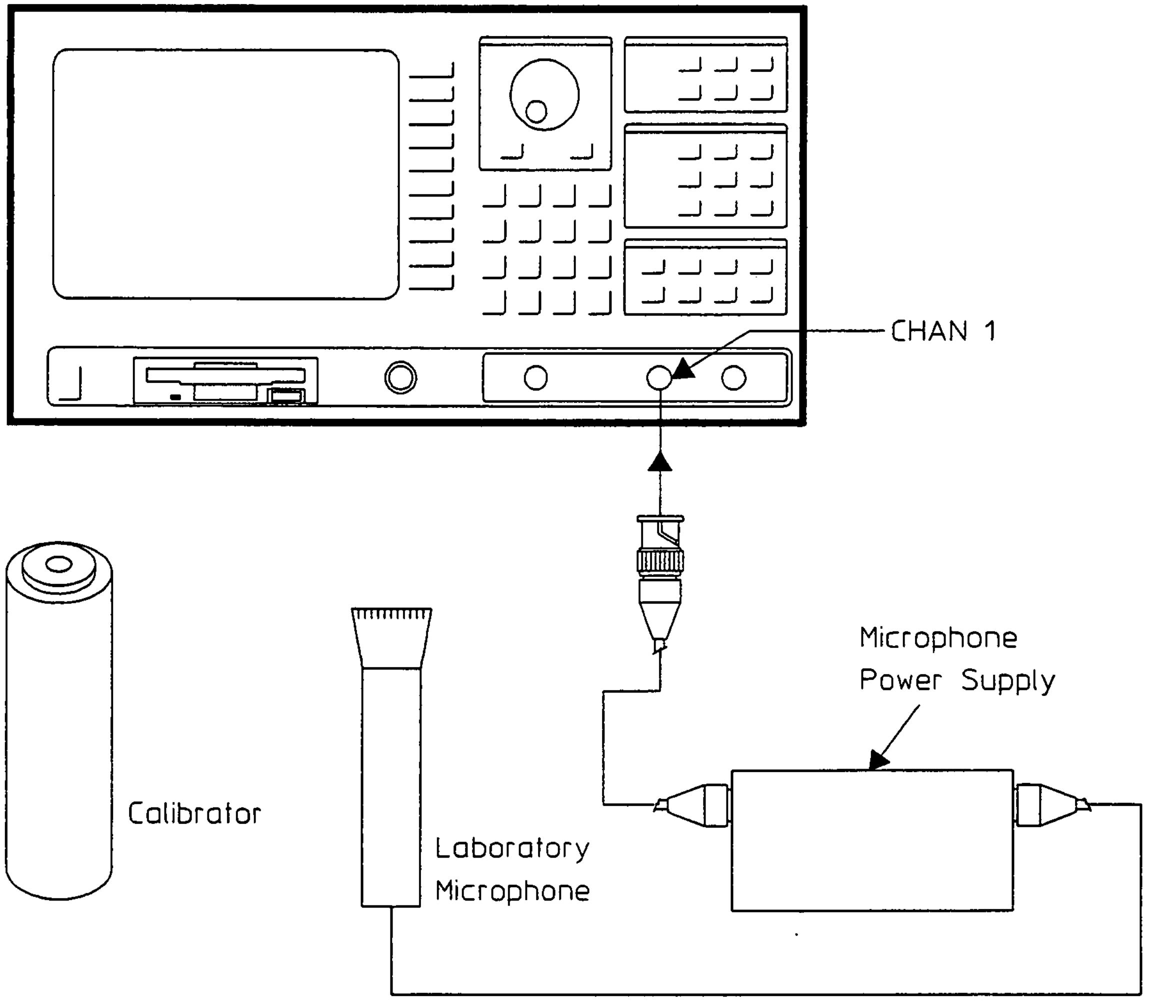
What you will need:

- One connecting cable, 12 inches (30 cm) or longer; this should be a BNC male to BNC male. This cable is not necessary if you are using a microphone with a long cable and a BNC male connector.
- Laboratory microphone and calibrator. You do not need these items if you are using the *HP Dynamic Signals Demo Disc* (see below).
- Noise source—live or recorded. The noise source and cal tone used for this example were taken from the *HP Dynamic Signals Demo Disc* (HP part number 35665-84401). If you are using this disc, you will need a Compact Disc player and associated cables and adapters to connect it to the HP 35665A.

What you will do:

- Select the analyzer's Octave Analysis mode and look at third-octave acoustic noise spectra.
- Learn about microphone calibration.
- Learn how to use engineering units to make SPL measurements.
- Select the analyzer's A-weight filter and use it to make an A-weighted SPL measurement.

Task Setup


CHAN 1
Microphone Power Supply
Calibrator
Laboratory Microphone

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. If the analyzer is turned off, turn it on.

   Then press [**Preset**] and

   press [DO PRESET].

Pressing [**Preset**] returns most of the analyzer settings to their default positions.

2. Press [**Inst Mode**] and

   press [OCTAVE ANALYSIS].

This configures the analyzer to make octave measurements. Notice how the X-axis is automatically changed to a logarithmic scale.

Octave mode is different than the analyzer's other instrument modes since it makes measurements that simulate proportional bandwidth filters. This provides resolution that is equal across each octave span.

The default resolution for Octave mode is third octave (1/3). This is standard for many acoustics measurements. Also available are full octave (1/1) resolution and twelfth octave (1/12) resolution.

3. Connect the microphone input to the analyzer's channel 1 input. If you are using the demonstration disc, connect the right channel of your Compact Disc player to the analyzer's channel 1 input.

For acoustics measurements, you should use a laboratory-grade condenser microphone. Hewlett-Packard microphones are available for this type of measurement; see the *HP Physical Sensors Catalog* (HP part number 5952-2996).

If you are using the demonstration disc, make sure you ground the analyzer's input connector by pressing [**Input**], [CHANNEL 1 SETUP], and toggling [INPUT LOW FLOAT **GND**]. This prevents possible ground loops that could generate an overloaded measurement.

4. Attach a calibrator to the microphone, or use the microphone calibration track on the demonstration disc (track 9, right channel).

In the example here, we are using a calibrator that supplies a 250 Hz cal tone at 100 dBspl.

Calibration must be done unweighted. When you preset the analyzer at the start of this task, the input A-weight filter was turned off if it had been on from a previous measurement.

4. Press [**Pause-Cont**].

5. Press [**Scale**] and

   toggle to [AUTOSCALE**ON** OFF].

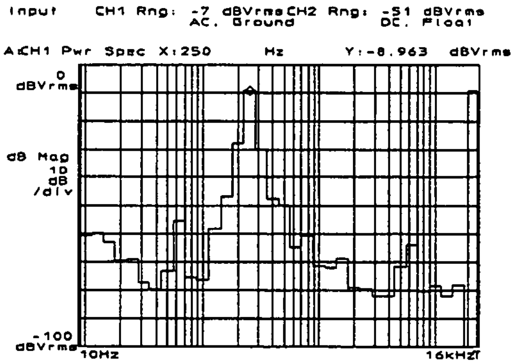
This turns on autoscaling.

Autoscaling means the analyzer automatically selects an appropriate scale for the currently displayed trace. Autoscaling does not make your measurement more accurate, but it often makes it easier to view your measurement results.

6. Press [**Marker**] and

   press [MARKER TO PEAK].

This moves the marker to the 250 Hz third-octave band. The level in this example is about –9 dBVrms. For an acoustics measurement, however, we need to set this marker value to 100 dBspl, since we know this to be the absolute level of this microphone calibrator. In a moment, we'll show how to do this with *engineering units*.



7. Press [**Input**],

   press [CHANNEL 1 SETUP],

   press [ENG UNIT LABEL],

   press [CLEAR ENTRY].

   Using the alpha keys, enter "SPL."

   Then press [ENTER].

You've just told the analyzer that you want the marker amplitude values express in units of SPL.

8. Press [ENG UNIT AT MKR].

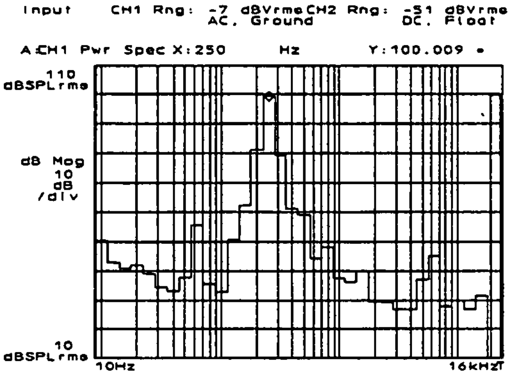
   Enter 100, then press [dBEUrms].

This sets the amplitude of the current marker position to 100 dBspl(rms). Until you change this reference (or preset the analyzer), all amplitude values are referenced to an absolute level of 100 dBspl(rms) if you use engineering units.

9. Now toggle to [ENG UNIT **ON** OFF].

This tells the analyzer that you want amplitude values displayed in engineering units. You can turn on or turn off engineering units at any time—and unless you preset the analyzer (or turn it off), the values that you specified for engineering units are retained.

10. Press [**Start**].



Notice how the amplitude values are now shown in dBspl(rms).

To make sure that you set the engineering units correctly, keep the calibrator attached to the microphone. The amplitude value for the 250 Hz octave band should read close to 100 dBspl(rms).

(If you are using the demonstration disc, you may have to restart track 9 again. Do not change the volume of the Compact Disc player, as this will make the cal tone inaccurate.)

11. Remove the microphone calibrator.

    Press [**Input**],

    press [CHANNEL 1 SETUP],

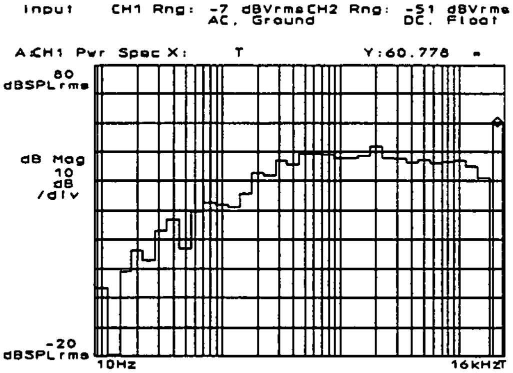
    and toggle to [A WT FLTR **ON** OFF].

This turns on the analyzer's channel 1 input A-weight filter. Notice how the **AW1** indicator (at the top of the display) turns on—this lets you know that the measurement is now A-weighted.

As we mentioned, an A-weight filter is useful for acoustics measurements and for characterization of audio-frequency devices since its response simulates that of the human ear. To learn more about weighting, see the *HP 35665A Concepts Guide*.

You can also apply a weighting function *after* making a measurement—by using an A-, B-, or C-weighting math operation. To learn more about math functions, see the *HP 35665A Concepts Guide*.

12. Then measure a typical noise source.



In the example here, we measured a typical desktop impact printer, without a noise shroud (this is track 10 of the demonstration disc). As you can see, the total A-weighted SPL is about 60 dB.

Chapter 6

Impact Testing

Impact Testing

Task Overview

This task shows how to use the analyzer's FFT Analysis mode to make a typical impact test measurement. You can use any appropriate mechanical device. In this example (from the *HP Dynamic Signals Demo Disc*), we used a brake rotor from an automobile.

All structures have natural frequencies of resonance. Structures like brake rotors can vibrate excessively because normal use excites a structural resonance. If this vibration is at an audio frequency, people riding in the car will hear the sound as brake squeal.

To find the natural frequencies, an impulse response measurement is performed on the structure, and the analyzer computes the frequency response of the structure. An instrumented hammer is used to impact the structure, and an accelerometer is used to measure the response.

Note

Keep in mind that impact test setups, test procedures, and test results are very much dependent on the type of structure you are testing. The sample task in this chapter is designed only to introduce some of the analyzer's measurement capability for impact measurements. *This chapter is not a tutorial on how to make impact measurements!* Impact testing is a very complex topic and one well beyond the scope of this book.

What you will need:

If you are using the *HP Dynamic Signals Compact Disc* (HP part number 35665-84401), you need the following items:

- A Compact Disc player.
- Cables and adapters to connect the player to the HP 35665A.

If you are using a mechanical test device, you need the following items:

- A mechanical test structure. In this example we used a brake rotor from an automobile.
- An impact hammer with built-in load cell and an appropriate connecting cable.
- An accelerometer with an appropriate connecting cable and adhesive or threaded stud (to mount the transducer to the test structure).

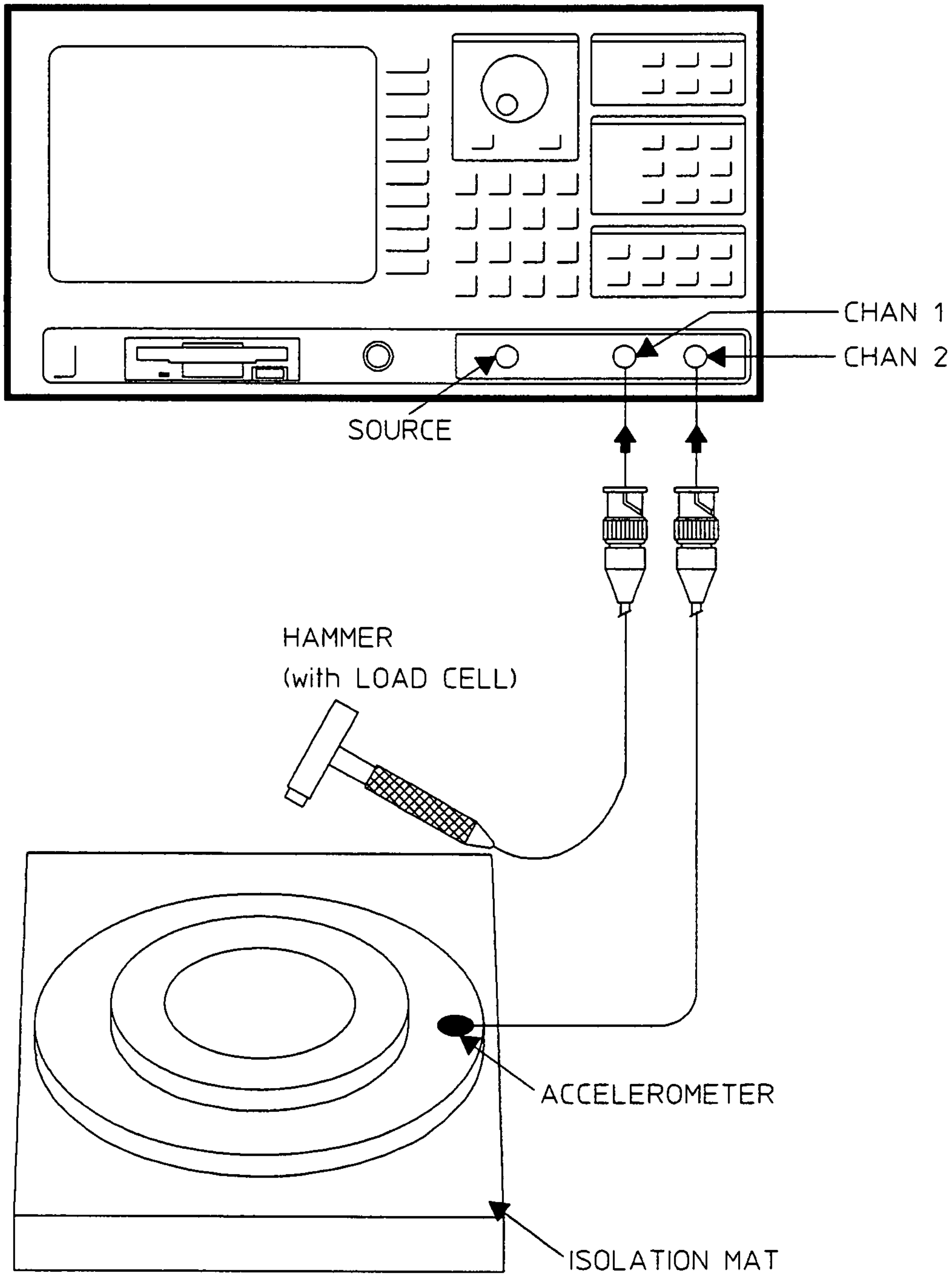
What you will do:

- Look at the frequency response of a simple mechanical structure, using impact testing.

What you will learn:

- How to set input range manually.
- How to specify trigger delay.
- How to use the force window and specify its width.
- How to use the exponential window and specify its decay rate.
- How to use manual preview.

Task Setup


CHAN 1
CHAN 2
SOURCE
HAMMER
(with LOAD CELL)
ACCELEROMETER
ISOLATION MAT

The Task

As you step through the following task, your measurement results will be different than those shown here, since your device-under-test may be different from the one used in this sample task. Keep in mind that these tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. If the analyzer is off, turn it on.

   If the analyzer is on, press [**Preset**] and press [DO PRESET].

   Presetting returns most of the analyzer settings to their default positions.

2. Connect the impact hammer to the analyzer's channel 1 input. If you are using the *HP Dynamic Signals Demo Disc*, attach the left channel from the disc player to the analyzer's channel 1 input.

   Attach the accelerometer to the back of the test structure, at the same point where you will hit with the hammer on the front. Connect the cable to the analyzer's channel 2 input. If you are using the *HP Dynamic Signals Demo Disc*, attach the right channel from the disc to the analyzer's channel 2 input.

   This measurement is referred to as a driving point measurement because the response accelerometer is placed at the point where the impact hammer hits the device.

3. Press [**Inst Mode**] and press [2 CHANNEL].

   This configures the analyzer to make two channel measurements. Network measurements (such as impact testing) can only be made in two channel mode.

4. Press [**Freq**] and
   press the down arrow key ([↓])
   until the entry box reads
   "SPAN = 3.2 kHz."

   For this example measurement, a frequency span of 3.2 kHz is appropriate.

5. Press [**Disp Format**] and
   press [UPPER/LOWER].

   To view the magnitude and phase, you need display two traces.

6. Press [**Meas Data**], and
   press [FREQUENCY RESPONSE].

   Display frequency response on trace A.

   Press [**Active Trace**], and
   press [FREQUENCY RESPONSE].

   Display frequency response on trace B.

7. Press [**Trace Coord**] and
   press [PHASE].

   The analyzer now displays dB magnitude on trace A and phase on trace B.

8. Press [**Input**] and
   press [CHANNEL 1 RANGE].
   Press [+/–] and type 1.9897
   (on the numeric keyboard).

   Press [dBVpk].

   This sets the channel 1 input range to –1.9897 dBVpk. This is an appropriate range for this example measurement. Your measurement may require a different range.

9. Press [CHANNEL 2 RANGE].
   Press [+/–] and type 5.9897
   (on the numeric keyboard).

   Press [dBVpk].

   This sets the channel 1 input range to –5.9897 dBVpk. This is an appropriate range for this example measurement. Your measurement may require a different range.

10. Press [**Trigger**] and
    press [CHANNEL 1 TRIGGER].

    This instructs the analyzer to trigger from a signal on channel 1.

11. Press [TRIGGER SETUP] and
    press [LEVEL].

    Type 5 (on the numeric
    keyboard) and
    press [PERCENT (%)].

    This instructs the analyzer to trigger when the input signal reaches 5% of the input range setting.

12. Press [CHANNEL 1 DELAY].
    Press [+/–] and type 1.9531
    (on the numeric keyboard).
    Press [mS].

    This instructs the analyzer to begin the measurement 1 msecond before the trigger signal. This allows you to see the leading edge of the hammer tap.

13. Press [CHANNEL 2 DELAY].
    Press [+/–] and type 1.9531
    (on the numeric keyboard).
    Press [mS].

    This sets the channel 2 delay to match channel 1.

14. Press [**Window**] and
    press [FORCE EXPO].

    This specifies the force and exponent windows.

    Toggle to
    [CHANNEL 1 **FORC** EXPO] and
    [CHANNEL 2 FORC **EXPO**].

    This specifies the force window for channel 1 and the exponential window for channel 2.

    Press [FORCE WIDTH],
    type 60 (on the numeric
    keyboard), and
    press [mS].

    Press [EXPO DECAY],
    type 80 (on the numeric
    keyboard), and
    press [mS].

    This specifies a force width of 60 ms and an exponential decay of 80 ms.

15. Press [**Scale**], and toggle to [AUTOSCALE **ON** OFF].

    Press [**Active Trace**], and toggle to [AUTOSCALE **ON** OFF].

    This turns on autoscaling for both traces. The analyzer scales the data to best fit the display.

16. Press [**Avg**], and toggle to [AVERAGE **ON** OFF].

    This turns averaging on. We use the default setting of rms average type and 10 averages.

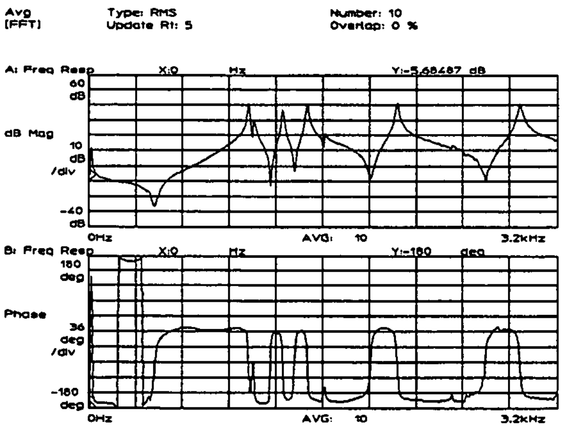
17. Press [**Start**].

    This starts the measurement.

18. Slowly tap the device 10 times with the impact hammer at or near the accelerometer. (If you are using the signal from the compact disc player—and your player has a repeat mode—you can repeat track 44 repeatedly.)

    If your hammer taps consistently result in overloads, increase the input ranges (steps 8 and 9)until overloads no longer occur.

    After 10 averages, the display looks something like this.



Avg
[FFT]
Type: RMS
Update Rt: 5
Number: 10
Overlap: 0 %

A: Freq Resp
X:0 Hz
Y:-5.68487 dB
60 dB
dB Mag
10 dB /div
-40 dB
0Hz
AVG: 10
3.2kHz
B: Freq Resp
X:0 Hz
Y:-180 deg
180 deg
Phase
36 deg /div
-180 deg
0Hz
AVG: 10
3.2kHz

19. If Trace A is not the active trace, press [**Active Trace**].

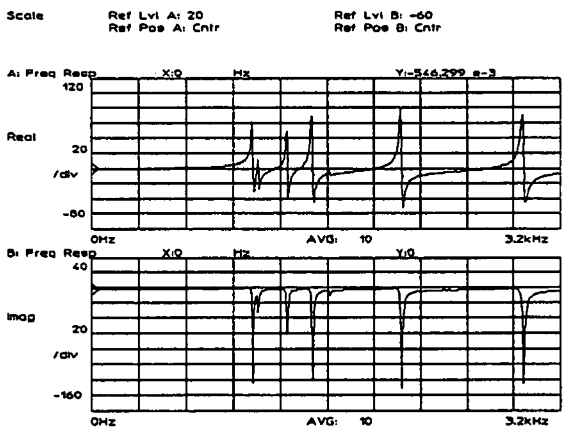
20. Press [**Trace Coord**], press [MORE], and press [REAL PART].

    Press [**Active Trace**], and press [IMAGINARY PART].

    This selects Trace B as the active trace and assigns the imaginary part to it.

    Press [**Scale**], and toggle to [AUTOSCALE **ON** OFF].

    Press [**Active Trace**], and toggle to [AUTOSCALE **ON** OFF].



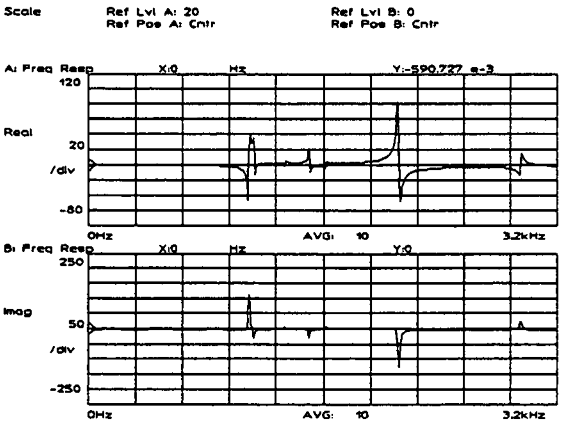
Now the analyzer displays real and imaginary instead of magnitude and phase. Note that the imaginary components all point in the same direction. This is characteristic of a driving point measurement.

21. Now tap the structure in a different location. For this example, the accelerometer and the impact point for the hammer are at the outer part of the disc surface and are separated by 90 degrees.

    Press [**Start**].

    Tap the structure 10 times (or play track 45 on the compact disc in the repeat mode, if you can).

In this example, the resonant frequencies in the frequency response are the same as the previous example, but the relative amplitudes at each resonance are different. Notice that the imaginary components do not all point in the same direction.



22. Press [**Freq**] and press the down arrow key ([↓]) until the entry box reads "SPAN = 1.6 kHz."

For this example measurement, a frequency span of 1.6 kHz is appropriate.

23. Press [**Active Trace**], press [**Meas Data**], and press [TIME CHANNEL 1].

This displays time channel 1 on Trace B.

24. Press [**Active Trace**], press [**Trace Coord**] and press [dB MAGNITUDE].

25. Press [**Window**],
    press [FORCE WIDTH],
    type 15 (on the numeric keyboard), and
    press [mS].

    Press [EXPO DECAY],
    type 100 (on the numeric keyboard), and
    press [mS].

This specifies a force width of 15 ms and an exponential decay of 100 ms.

26. Press [**Active Trace**], and
    toggle to [AUTOSCALE **ON** OFF].

27. Press [**Avg**],
    toggle to [AVERAGE ON **OFF**],
    press [PREVIEW SETUP],
    press [MANUAL PREVIEW].

This turns on manual preview. Preview lets you examine each time record and decide whether or not to include the data in an averaged measurement. (In this example, averaging is off so that you can see the difference between good and bad hammer impacts.)

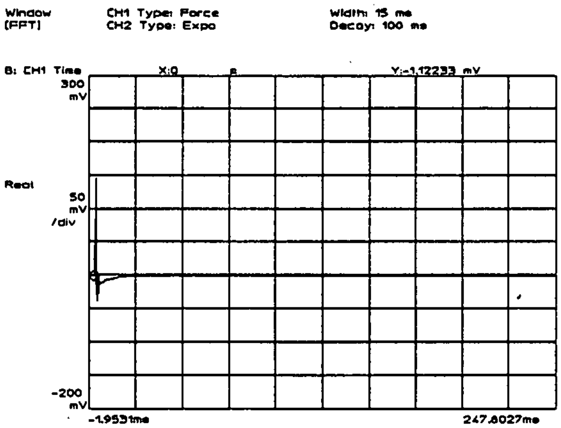
28. Do a hammer tap (or play track 46 on the compact disk).

    When the message "WAITING FOR ACCEPT/REJECT" appears, press [ACCEPT TIME REC].

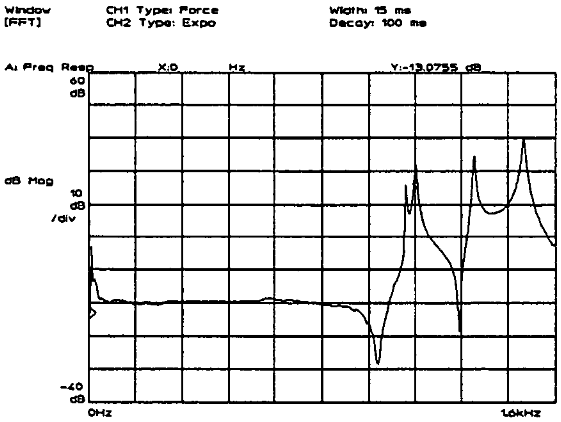
When the analyzer receives a trigger, it displays the time record for channel 1 on trace A and the time record for channel 2 on trace B. After you accept the data, the analyzer displays frequency response on trace A and time channel 1 on trace B.

    Compare the results to the following examples. These traces illustrate the results of a single, good hammer tap, multiple taps, and an overloaded input channel.

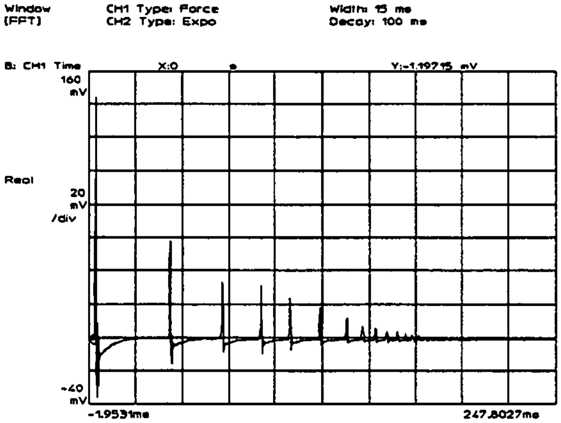
    If your hammer taps consistently result in overloads, increase the input range until overloads no longer occur.



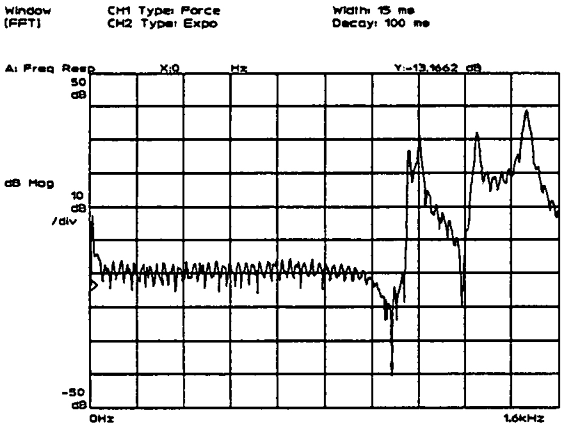
This trace shows the time domain results of a single, good hammer tap.



This trace shows the frequency response of a single, good hammer tap.

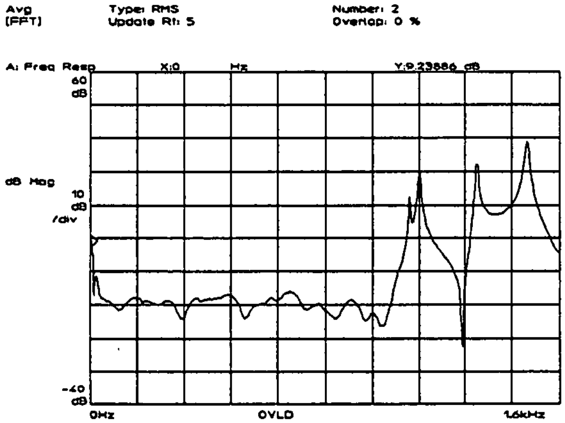


This trace shows the time domain result of a multiple impact, such as when the hammer bounces during impact.


Window (FFT) CH1 Type: Force CH2 Type: Expo Width: 15 ms Decay: 100 ms

A: Freq Resp X:0 Hz Y:-13.1662 dB

This trace shows the frequency response of multiple impact, such as when the hammer bounces during impact. Notice that a multiple impact produces a ripple on the frequency response.


Avg (FFT) Type: RMS Update Rt: 5 Number: 2 Overlap: 0 %

A: Freq Resp X:0 Hz Y:9.23886 dB

This trace shows the frequency response with channel 1 overloaded. Notice that the overload causes distortion in the frequency response.

chapter 7

Analysis Tasks

Chapter 7

Limit Testing

7

Limit Testing

Introduction

This chapter provides a brief overview of limit testing. We've included several sample tasks that show you how to build limits and then use them.

A limit test is a line (or set of lines) that you create to check the performance of a signal source or a device-under-test. When limit testing is on, the analyzer compares a current measurement or a stored trace to the limit you've selected.

A limit appears as a single line (upper or lower limit) or two lines (upper and lower limit). If a trace exceeds the boundaries of these lines, the limit test fails. Limit testing is useful for go/no go checking since a limit test quickly tells you if your device-under-test passes or fails a particular limit test.

You can build a limit line—an upper limit, a lower limit, or set of both upper and lower limits—in several different ways:

- By using the knob (or numeric entry) to arbitrarily construct a limit line
- By saving a trace, recalling it as a limit, and shifting this newly-created limit up or down to form an upper or lower limit
- Via HP-IB

Task 1: Building an Arbitrary Limit

Task Overview

This task shows you how to build an arbitrary limit line. In this example, we're going to test the performance of a 1 kHz bandpass filter. However, you can use a filter that has a different passband—the important thing is to understand the measurement task, not to duplicate the measurement results demonstrated here.

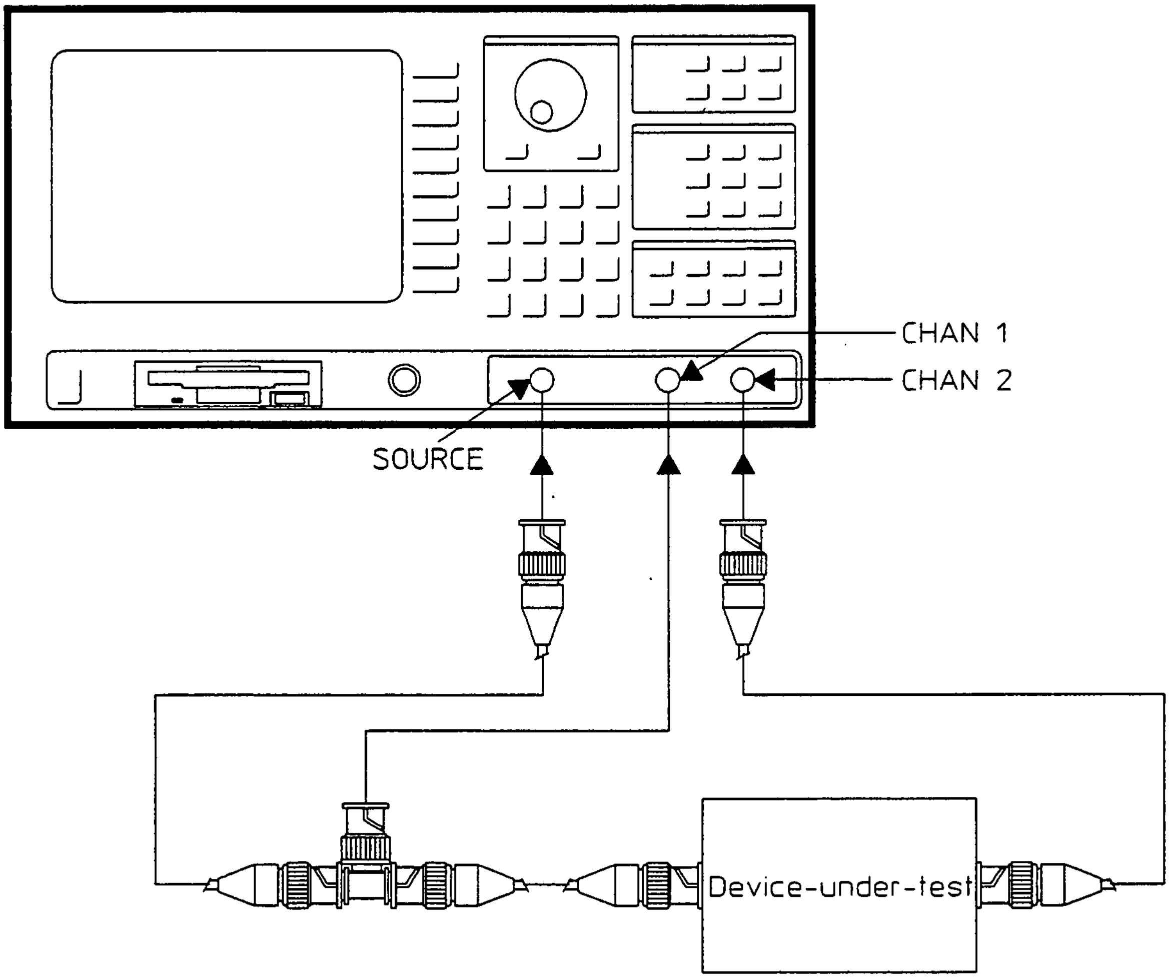
What you will need:

- Adjustable bandpass filter. In the example here, we used a 1 kHz bandpass filter with an adjustable response.
- Feedthrough terminators or impedance converters to match a test device with non-standard input/output impedances—this is usually not required.
- Appropriate connecting cables

What you will do:

- Build an arbitrary limit
- Compare your test device to this arbitrary limit
- Change the response of your test device to fail the limit test

Task Setup


CHAN 1
CHAN 2
SOURCE
Device-under-test

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. Connect a bandpass filter to the analyzer.

In this example, we used a simple 1 kHz bandpass filter with an adjustable response. Your filter should have an adjustment to vary the bandpass response, though this isn't absolutely necessary.

2. Make a frequency response measurement, to characterize the response of the bandpass filter. In the example here, we're using a frequency response measurement made with the analyzer's FFT Analysis mode. You could also do this task using the analyzer's Swept Sine mode.

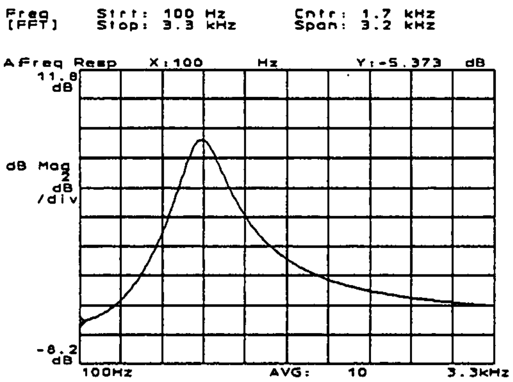
If you need review, use the procedures outlined in chapter 3.

4. Press [**Scale**], and

   press [CENTER REFERENCE].

   Then turn the knob to position the trace in the middle of the screen.

It's easier to build an upper limit if you leave some space above the trace.



5. Press [**Analys**] and

   press [LIMIT TEST].

In a moment, you will begin building a limit line.

7. Press [DEFINE UPPER LIM].

You are now ready to start "drawing" the upper limit.

8. Use the knob and the [MOVE MKR HORIZNTAL] and [MOVE MKR VERTICAL] softkeys to move the limit cursor to a convenient starting point.

In the example here, we chose a starting point to the left of the passband response.

9. When you've selected the starting point,

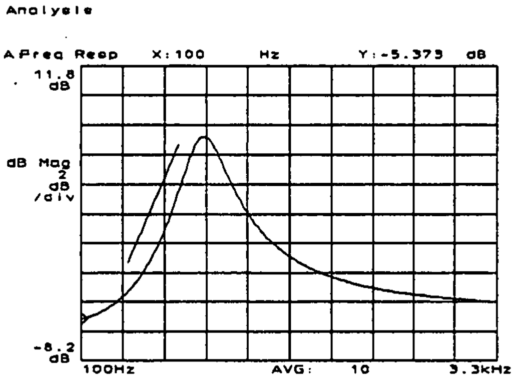
   press [START UPP SEG].

This anchors the start-point of this segment.

10. Again, use the knob and the [MOVE MKR HORIZNTAL] and [MOVE MKR VERTICAL] softkeys to move the limit cursor to the end point of this first segment.

The effect here is similar to stretching a rubber band.

11. Press [FINISH UPP SEG].


Analysis
A Freq Resp
X: 100
Hz
Y: -5.373
dB
11.8
dB
dB Mag
2
dB
/div
-8.2
dB
100Hz
AVG:
10
3.3kHz

This defines the end point of the first limit line segment. The second limit line segment will start where the first one ended.

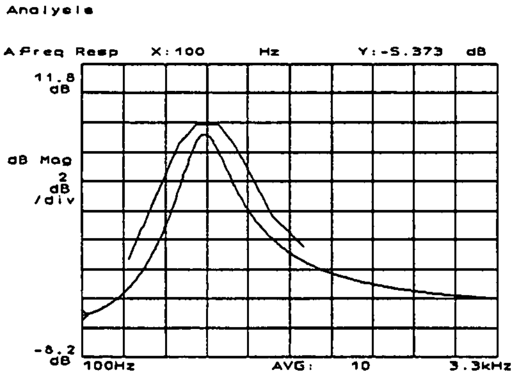
If you wish, you can leave spaces between a limit line segments to create a broken limit line. To do this, move the limit cursor to another location immediately after pressing [FINISH UPP SEG]. Then press [START UPP SEG]. The limit line continues from there.

Broken limit lines are sometimes more convenient—for example, when checking the harmonics of a signal source, or quickly checking bandpass ripple and stopband rejection for a bandpass filter.

But for the example we're using here—checking the response of a bandpass filter—a limit line formed by contiguous line segments is more useful.

12. Now use the knob and the [MOVE MKR HORIZNTAL] and [MOVE MKR VERTICAL] softkeys to move the marker cursor to the end point of the second segment.

    Then press [FINISH UPP SEG].


Analysis
A Freq Resp
X: 100
Hz
Y: -5.373
dB
11.8
dB
dB Mag
2
dB
/div
-8.2
dB
100Hz
AVG:
10
3.3kHz

Continue this process until you've finished the entire upper limit.

The more line segments you use, the smoother the limit line.

If you make a mistake, simply move the limit cursor to the defective limit segment and press [DELETE SEGMENT]. Then go back and draw the segment again.

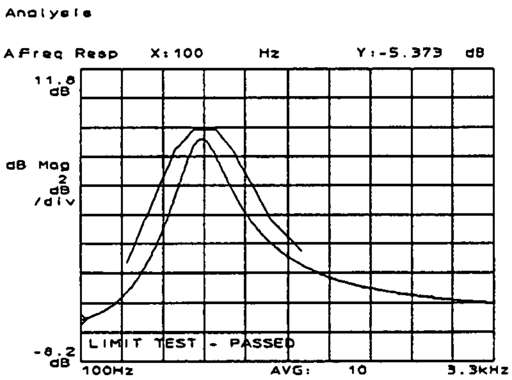
13. When you've finished drawing the upper limit, press

[RETURN].

Then toggle to
[TEST EVAL **ON** OFF].

This turns on the limit test evaluation. When test evaluation is on, you can see a message at the bottom of the display that indicates if the device-under-test has passed or failed the limit test.

If the trace remains below the upper limit, the message "LIMIT TEST – PASSED" appears. If the trace exceeds the upper limit, "LIMIT TEST – FAILED" appears.

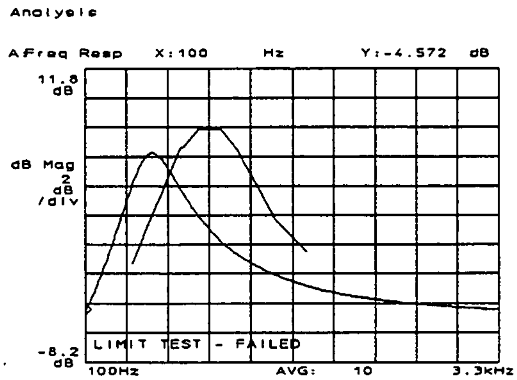

Analysis
AFreq Resp X: 100 Hz Y: -5.373 dB
11.8 dB
dB Mag
2 dB /div
-8.2 dB
100Hz
AVG: 10
3.3kHz

LIMIT TEST - PASSED

14. Now vary the response of your bandpass filter until the limit test fails.

Then press [**Start**].

In the example here, we changed the center frequency of the test filter from 1 kHz to 500 Hz.


Analysis
AFreq Resp X: 100 Hz Y: -4.572 dB
11.8 dB
dB Mag
2 dB /div
-8.2 dB
100Hz
AVG: 10
3.3kHz

LIMIT TEST - FAILED

Task 2: Building a Limit from a Trace

Task Overview

This task shows you how to build upper and lower limit lines from an existing trace. In this example, we're going to test the performance of a simple 1 kHz bandpass filter. However, you can use a filter that has a different passband—the important thing is to understand the measurement task, not to duplicate the measurement results demonstrated here.

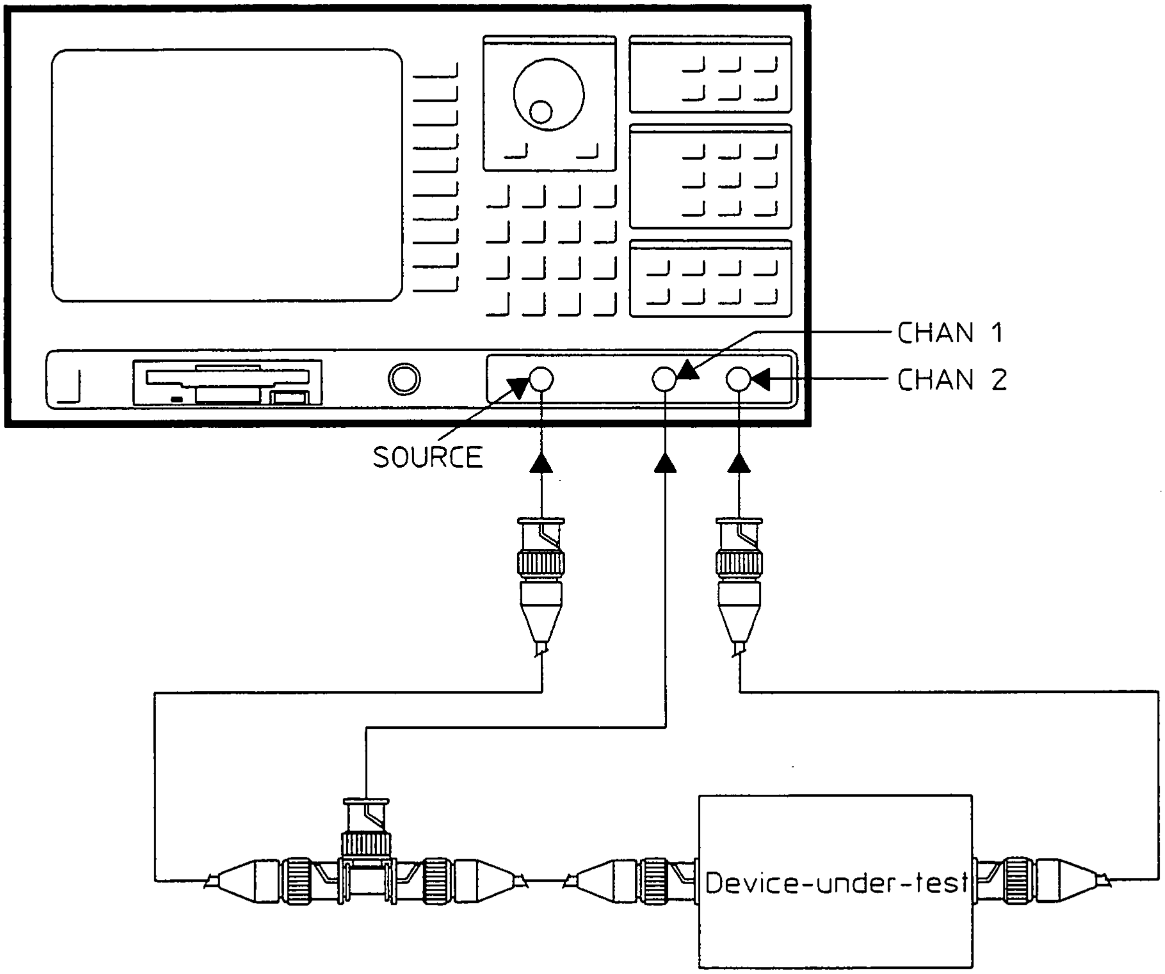
What you will need:

- Adjustable bandpass filter. In the example here, we used a 1 kHz bandpass filter with an adjustable response.
- Feedthrough terminators or impedance converters to match a test device with non-standard input/output impedances—this is usually not required.
- Appropriate connecting cables

What you will do:

- Create both an upper and a lower limit from an existing trace
- Move both upper and lower limits to form an acceptable limit test
- Compare your test device to the newly-formed limits
- Change the response of your test device to fail the limit test

Task Setup


CHAN 1
CHAN 2
SOURCE
Device-under-test

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. Connect a bandpass filter to the analyzer.

In this example, we used a simple 1 kHz bandpass filter with an adjustable response. Your filter should have an adjustment to vary the bandpass response, though this isn't absolutely necessary.

2. Make a frequency response measurement, to characterize the response of the bandpass filter. In the example here, we're using a frequency response measurement made with the analyzer's FFT Analysis mode. You could also do this task using the analyzer's Swept Sine mode.

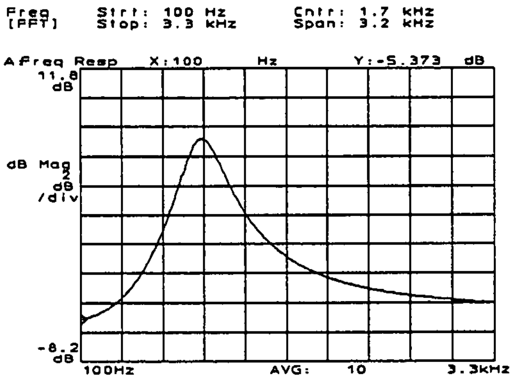
If you need review, use the procedures outlined in chapter 3.

4. Press [**Scale**], and

   press [CENTER REFERENCE].

   Then turn the knob to position the trace in the middle of the screen.

It's easier to build an upper limit if you leave some space above the trace.



5. Press [**Analys**] and

press [LIMIT TEST].

In a moment, you will begin building a limit line.

6. Press [DEFINE UPPER LIM] and

press [TRACE TO LIMIT].

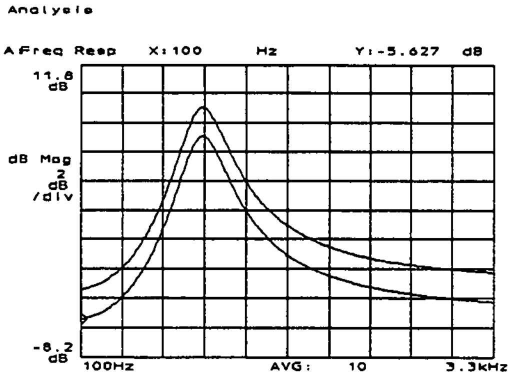
You have just created a limit from the displayed trace. You can't see the newly-created limit right now, since the analyzer has drawn it directly over the displayed trace.

7. Press [MOVE ALL VERTICAL].

Then use the knob to move the limit line above the trace.

This lets you move the newly-created limit line.

In the example here, we moved the upper limit 2 dB above the displayed trace.



8. Press [DEFINE LOWER LIM],

Press [CANCEL/RETURN],

press [TRACE TO LIMIT].

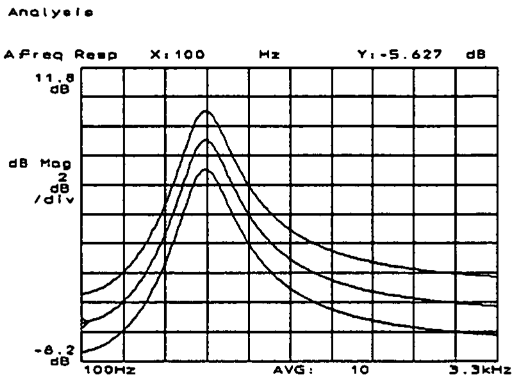
You have just created a limit from the displayed trace. Again, you can't see the newly-created limit since the analyzer has drawn it directly over the displayed trace.

9. Press [MOVE ALL VERTICAL].

   Then use the knob to move the limit line below the trace.

This lets you move the newly-created limit line.

In the example here, we moved the lower limit 2 dB below the displayed trace.


Analysis
A Freq Resp
X: 100 Hz
Y: -5.627 dB
11.8 dB
dB Mag
2 dB /div
-8.2 dB
100Hz
AVG: 10
3.3kHz

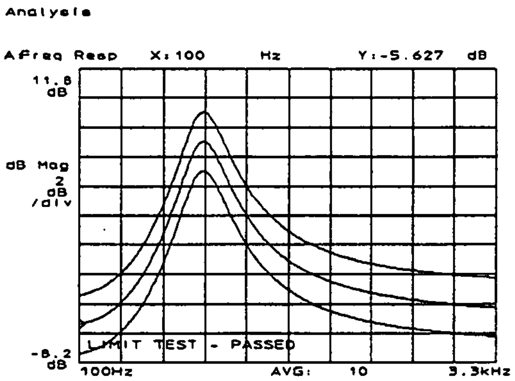
10. When you're done moving the bottom limit,

    press [RETURN].

    Then toggle to [TEST EVAL **ON** OFF].

This turns on the limit test evaluation. When test evaluation is on, you can see a message at the bottom of the display that indicates if the device-under-test has passed or failed the limit test.

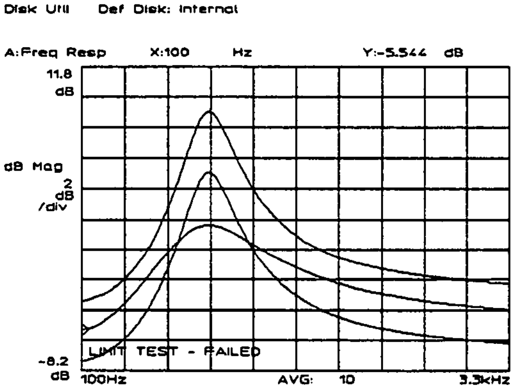
If the trace remains below the upper limit, the message "LIMIT TEST – PASSED" appears. If the trace exceeds the upper limit, "LIMIT TEST – FAILED" appears.

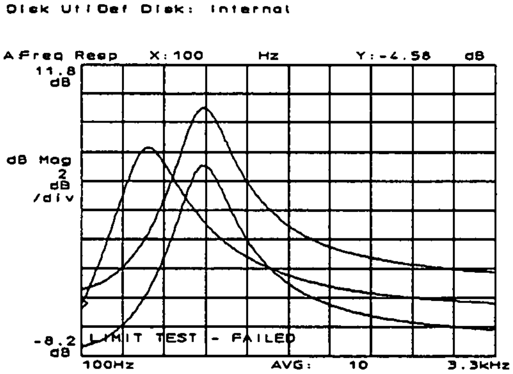

Analysis
A Freq Resp
X: 100 Hz
Y: -5.627 dB
11.8 dB
dB Mag
2 dB /div
-8.2 dB
100Hz
AVG: 10
3.3kHz

LIMIT TEST - PASSED

11. Now vary the response of your bandpass filter until the limit test fails.

    Then press [**Start**].





In the first example, we changed the peak response of the test filter. In the second example, we changed the center frequency of the test filter from 1 kHz to 500 Hz.

Chapter 8

Using Keystroke Recording to Generate an HP Instrument BASIC Program

8

Using Keystroke Recording to Generate an HP Instrument BASIC Program

Introduction

This chapter shows you how to capture a sequence of measurement tasks using the analyzer's *keystroke recording* feature. When keystroke recording is on, the analyzer records your key presses (hardkeys, softkeys, and alpha/numeric entries) and automatically generates an HP Instrument BASIC program that reflects each of these key presses. *This feature is available only if your analyzer is equipped with the HP Instrument BASIC option.*

When you finish a measurement procedure, you can turn off keystroke recording. At this point, you can display the program on the analyzer's screen, edit the program, and then save it to a file on the analyzer's internal disk. Or if you prefer, you can simply save the unedited file to the analyzer's internal disk and move the disk to an external system for editing.

To learn more about HP Instrument BASIC, see *Using HP Instrument BASIC with the HP 35665A.* To learn more about the individual commands used to program the analyzer, see *HP-IB Programming with the HP 35665A*.

What is HP Instrument BASIC?

HP Instrument BASIC (a subset of the HP BASIC programming language) is a complete system controller residing inside your analyzer. The HP Instrument BASIC software communicates with the analyzer via HP-IB commands, and can also communicate with other instruments, computers, and peripherals over the HP-IB.

HP Instrument BASIC is available as an option with the HP 35665A Dynamic Signal Analyzer. When installed, you can use it for a wide range of applications—from simple recording and playback of measurement sequences (*keystroke recording*) to sophisticated remote-control operation of other instruments, computers, and peripherals.

This chapter provides only a brief introduction to keystroke recording. It also includes a demonstration of how easy it is to subsequently edit this HP Instrument BASIC program generated by your keystroke sequence.

Task Overview

This chapter steps you through a common measurement and shows you how to record the keystrokes of this task using HP Instrument BASIC. *To complete this task, your analyzer must be equipped with the HP Instrument BASIC option.*

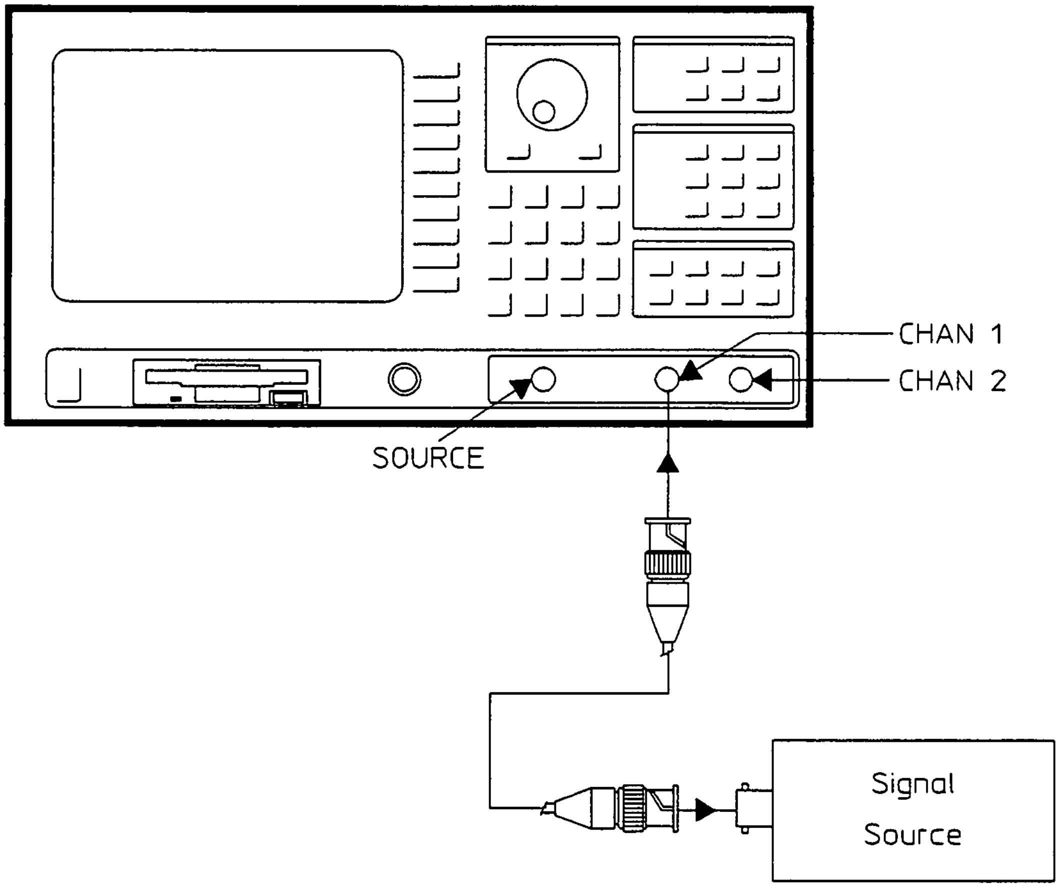
What you will need:

- An HP 35665A *with the HP Instrument BASIC option*
- One connecting cable, 12 inches (30 cm) or longer; this should be a BNC male to BNC male.
- External signal generator (optional).
- Appropriate feedthrough terminator for external signal generator (if necessary).

What you will do:

- Turn on keystroke recording, make a simple measurement, and then store this measurement sequence as an HP Instrument BASIC program
- Recall the stored program and edit it
- Learn about measurement restart procedures and the *WAI command
- Gain an introduction to both keystroke recording and the HP Instrument BASIC programming language

Task Setup


CHAN 1
CHAN 2
SOURCE
Signal
Source

The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. Connect a signal source to the analyzer's channel 1 input. You can use either the analyzer's source or an external signal generator.

   Then display this signal, making sure there is at least one prominent harmonic.

If you need review, use the procedures outlined in chapter 2.

This task searches for a harmonic, so your test signal should have at least one prominent harmonic. The amplitude and frequency of the test signal is not critical—in the example here, we're using a 10.24 kHz sine signal from the analyzer's source.

2. Press [**BASIC**],

   press [INSTRUMENT BASIC],

   press [UTILITIES],

   press [SCRATCH],

   press [PERFORM SCRATCH],

   press [RETURN].

The *scratch* operation erases any previous HP Instrument BASIC program that may have been in the analyzer's program buffer.

When preparing to start a keystroke recorded sequence, it's a good idea to clear the program buffer. Otherwise, your keystroke sequence will be added to the existing program.

3. Press [ENABLE RECORDING].

This turns on keystroke recording. Anything you do from this point on will be recorded as a set of instructions in the analyzer's program buffer.

Keystroke recording continues until you press [**BASIC**] once more.

5. If you are using an external signal source, press [**Preset**] and [DO PRESET].

   Skip this step if you're using the analyzer's source for this task.

This records a preset operation into the program now being stored.

Normally, it's a good idea to preset before starting *any* measurement procedure. This is especially important for automated procedures, to provide measurements that are both consistent and repeatable.

If you're using the analyzer's source for this task, don't preset the analyzer. If you do, you will have to set up the source again. Since we don't want to include the source setup as part of our demonstration of keystroke recording, continue to the next step.

6. Press [**Avg**] and

   toggle to [AVERAGE **ON** OFF].

This turns on averaging. Remember, every keystroke you make is being recorded. Be careful not to press any extra keys, or you will have to delete these keypresses later.

Although averaging isn't necessarily required for the measurement procedure demonstrated here, averaging slows the measurement sequence somewhat—and this will make it easier for you to watch the recalled program run when the analyzer steps through the automated measurement procedure.

7. Press [**Start**].

While it may not seem necessary to restart the measurement, pressing [**Start**] inserts both a start procedure (the ABOR and INIT commands) and a wait command (*WAI) into the program now being recorded. Without these commands, the recalled program will not work correctly.

The start procedure aborts the current measurement and begins a new measurement. The wait command ensures that the analyzer's internal processing is completed before the analyzer actually makes a measurement. Both commands are very important and are frequently used in HP-IB programming.

More specifically, the *WAI command ensures that the analyzer acquires the necessary measurement data before performing subsequent operations. For example, a marker-to-peak command will not find the proper peak if the peak search operation occurs before the analyzer displays the measurement data.

To learn more about *WAI, see *HP-IB Programming with the HP 35665A*.

8. Press [**Marker**],

   press [MARKER TO PEAK],

   press [REFERENCE TO MARKER],

   press [NEXT PEAK RIGHT].

This moves the marker to the fundamental, turns on the relative marker and zeroes it on the fundamental, and moves the marker to a prominent harmonic.

9. Press [**BASIC**].

This turns off keystroke recording.

10. Press [**Marker**] and

    toggle to [MARKER ON **OFF**].

This turns off the analyzer's marker. This step is not really necessary—but if you turn off the marker, you will more clearly see how the analyzer performs the automated marker operations when you start the program in the next step.

11. Now it's time to test the stored program.

    Press [**BASIC**] and

    press [RUN PROGRAM 1].

This runs the program you've just created.

12. The program should run successfully.

Here's what you should see (in this order):

a) a preset operation (if you did this step)

b) a new measurement start

c) a series of ten averages

d) a marker-to-peak operation

e) the relative marker turn on and zero at the peak

f) the marker move to the second harmonic

If the program does not run successfully, go back and record it again.

If you want to start over, go back to step 2. *Make sure you scratch (erase) the program buffer as shown in step 2.*

13. Press [**Save / Recall**],

    In a moment, you will save the program to a disk.

    press [DEFAULT DISK],

    press [VOLATILE RAM DISK].

    This establishes the analyzer's volatile RAM disk as the current disk.

    If you have a formatted 3.5-inch flexible disk, you can press [INTERNAL DISK] instead and use the analyzer's internal disk drive as the disk.

14. Press [RETURN].

    This returns you to the previous menu.

15. Press [SAVE MORE] and

    press [SAVE PROGRAM].

    To use the default program name, simply press [ENTER].

    To enter another program name, use the knob, the numeric-entry keys, and the alpha-shifted hardkeys.

    In the example here, we selected "PROG1" as the name.

    Afterwards, press [ENTER].

    When the analyzer prompts you for a name—a filename, for example—it automatically switches to alpha entry mode.

    In alpha entry mode, the analyzer shifts certain hardkeys to alpha entry keys (note the alpha characters engraved on the front panel below these hardkeys). You can also specify uppercase or lowercase letters, using the [UPPERCASE lowercase] softkey.

    If you make a mistake, you can use the appropriate edit softkeys to fix the name. You can also use the knob to help you edit.

    Alternatively, you can use an external keyboard to enter a filename.

16. At this point, you don't need to recall the program to run it again. This is because the program is still in the program buffer since you just created it.

    In a moment, you will clear the program buffer to practice recalling a program.

Unless the program you want to run is already in the analyzer's program buffer, you must first recall a program. This loads it into the program buffer.

17. Press [**BASIC**],

    press[INSTRUMNT BASIC],

    press [UTILITIES],

    press [SCRATCH],

    press [PERFORM SCRATCH],

    press [RETURN].

You've just cleared the program buffer.

18. Press [**Preset**] and [DO PRESET].

    Skip this step if you're using the analyzer's source for this task.

In a moment, you will recall the stored program, and edit it.

Presetting at this point isn't really necessary—we've done it here only to emphasize that you can recall a program after presetting the analyzer. And if we had saved the program to the non-volatile RAM disk or the internal disk, we could recall the program even after cycling the analyzer's power.

19. Let's recall the program.

    Press [**Save / Recall**],

    press [RECALL MORE],

    press [RECALL PROGRAM],

    press [ENTER].

The default name should be the name of the program you just stored. If it isn't, use the knob, the numeric-entry keys, and the alpha-shifted hardkey to specify the proper name. Then press [ENTER].

20. Press [**BASIC**].

    Notice how your newly-named program is now listed as a softkey in place of the [RUN PROG 1] softkey.

This makes it easier to select an appropriate HP Instrument BASIC program.

21. Press [INSTRUMENT BASIC] and

    press [EDIT].

This is the program you just recorded.

All programs begin with the statement
`ASSIGN @Hp35665a TO 800`
and terminate with an
END
command.

If you were to run this program from an external system controller, you must change the `800` in the first statement to the current HP-IB address of the HP 35665A you want controlled. `800` is used only when running this program from HP Instrument BASIC.

22. Using the knob, move to the line with the `"CALC1:MARK:MAX:RIGH"` statement.

    Then press [DELETE LINE].

    This removes the marker-to-next-right-peak operation. In a moment, you will run the program again to see how the automated measurement sequence reflects this change.

23. Now press [ENTER]. *This is very important!*

    The edits you make are not entered into the program buffer until you press [ENTER].

    Then press [END EDIT].

    This exits the editing mode.

24. If you are using an external signal source, press [**Preset**] and [DO PRESET].

    Skip this step if you're using the analyzer's source for this task.

    If you're using the analyzer's source for this task, don't preset the analyzer. If you do, you will have to set up the source again. Since we don't want to include the source setup as part of our demonstration of keystroke recording, continue to the next step.

25. Press [RUN PROGRAM] and

    press [PROG 1].

    This runs the program again.

    Notice how the marker does not move to the second harmonic—this is because we removed the marker-to-next-right-peak operation.

26. Let's see how easy it is to put back the marker-to-next-right-peak operation.

    As we mentioned earlier, subsequent keystroke recording procedures *add* to the program already in the buffer. This lets you insert additional command lines into the program buffer.

27. Press [INSTRUMNT BASIC].

    Press [EDIT].

    Using the knob, position the program cursor on the last line of the program (the line with the END command).

    When you begin keystroke recording in a moment, the additional command lines will be inserted *on the line above the program cursor.* For this reason, it's important to properly position the program cursor before adding new commands.

28. Press [END EDIT],

    press [ENABLE RECORDING],

    press [**Marker**],

    press [NEXT PEAK RIGHT],

    press [BASIC].

    This replaces the next-right-peak operation that you removed. Pressing BASIC concludes the keystroke recording sequence.

    Notice how simply pressing the Marker hardkey did not enter a command—this is because an HP-IB command is not generated for the Marker keypress itself. An important difference between the HP 35665A and older HP Instruments is that not every keypress has an equivalent HP-IB command. To learn more, see *HP-IB Programming with the HP 35665A*.

29. Press [PROG 1].

    The relative marker should now move to the second harmonic if you successfully inserted the marker-to-next-right-peak operation.

Chapter 9

Math Operations

Math Operations

Introduction

Using constants and functions, you can perform a variety of operations on current (or stored) traces. You can use math to modify the results of a measurement—for example, to compensate for a fixed gain (or loss) in a system- or device-under-test. You can also use a math operation to modify a trace—for example, to invert a trace. And you can use math to add, subtract, multiply, or divide traces with other traces.

This following tasks demonstrate some of the different ways that you can use the HP 35665A's math operations. Even if you don't have time to do all the tasks, try at least one of them.

For some of the tasks, you will need a test device. You can use the analyzer's own built-in A-weight filter. If you prefer, you can substitute an external device for the analyzer's built-in A-weight filter. These tasks assume that you already know how to make a frequency response measurement to characterize a device. If you need review, see chapters 3 and 4 of this book, or use the device characterization tasks in the *HP 35665A Quick Start Guide.*

Math Task 1: Inverting a Trace

Task Overview

This task shows how to invert a frequency response trace with a math function.

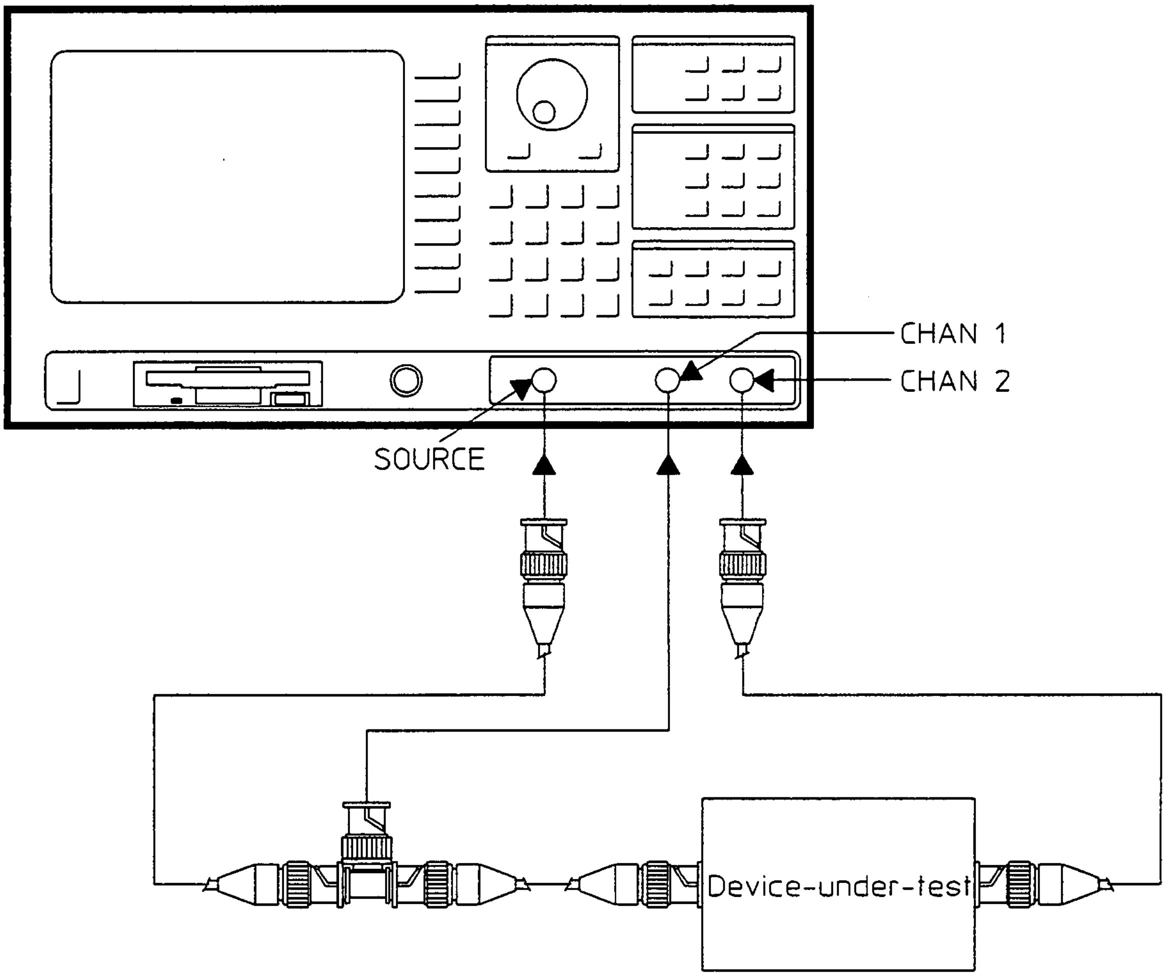
What you will need:

- A test device—for example, a filter. In the example here, we've used the analyzer's own A-weight filter. The choice of test device is arbitrary—you can use any device.
- Feedthrough terminators or impedance converters to match a test device with non-standard input/output impedances—this is usually not required.
- Appropriate connecting cables

What you will do:

- Make a frequency response measurement
- Invert the frequency response trace
- Multiply the reciprocal of the frequency response trace by the inverted trace to produce a flat response.

Task Setup


CHAN 1
CHAN 2
SOURCE
Device-under-test

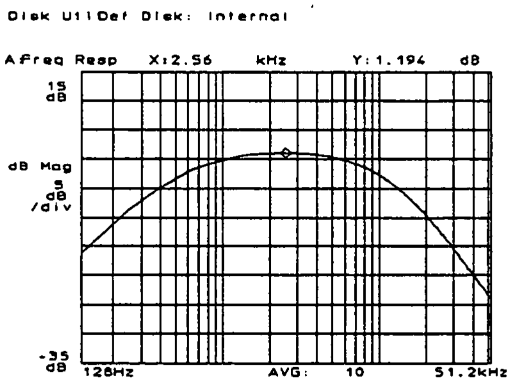
The Task

As you step through the following task, you may find that your measurement results differ slightly from those shown here. Keep in mind that the tasks are designed to help you learn about the analyzer—not to duplicate specific measurement results.

1. Connect a bandpass filter to the analyzer, or use the analyzer's internal channel 2 A-weight filter.

   Then make a frequency response measurement to characterize the test device.

   Follow the instructions as shown in chapter 3 or chapter 4.



In this example, we're using the analyzer's internal A-weight filter. The choice of a linear or logarithmic X-axis is not critical—math operations are not affected by this decision.

In the example here, we're using a frequency response measurement made with the analyzer's FFT Analysis mode. You could also do this task using the analyzer's Swept Sine mode.

This task assumes that you already know how to make a frequency response measurement to characterize a device. If you need review, see chapters 3 and 4 of this book, or use the device characterization tasks in the *HP 35665A Quick Start Guide*.

2. Press [**Analys**],

   press [DEFINE CONSTANT],

   press [DEFINE K1],

   If K1 is already equal to 1, skip to the next step.

   If K1 is *not* equal to 1, enter the number 1 with the numeric keypad. Then press [ENTER].

   This ensures that constant K1 is set to 1.

3. Press [RETURN].

   Press [DEFINE FUNCTION] and

   press [DEFINE F1].

   In a moment, we're going to define the math function that inverts the current frequency response trace.

4. Press [CONSTANT (K1–K5)],

   press [CONSTANT K1],

   press [/]

   [MEAS DATA]

   [FREQUENCY RESPONSE]

   [ENTER]

   You have just created a math function that generates the inverse of the current frequency response trace—in a moment, you'll be able to see the results of this function.

   Alternatively, you could have saved the original frequency response trace to a data register, and then used the contents of that data register in this math function. That way, the math function still works even if you no longer have your device-under-test connected to the analyzer.

5. Press [**Meas Data**],

   press [MORE],

   press [MATH FUNCTION],

   press [F1].

The math function is now displayed. At this point, you probably won't be able to see it very well since the display scaling is set to a default setting.

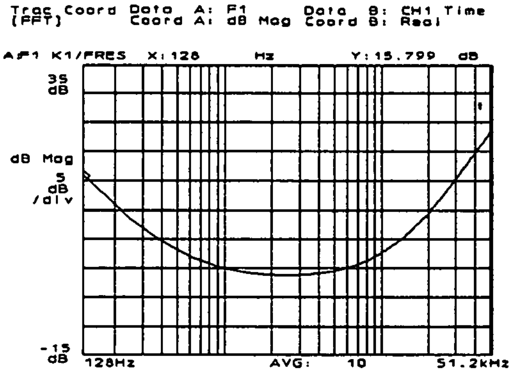
6. Press [**Scale**], then

   toggle to [AUTOSCALE **ON** OFF].

   If the X-axis scale is not logaritmic,

   press [**Trace Coord**] and

   toggle to [X-AXIS LIN **LOG**].



The trace you're now viewing is the inverse of the orignal frequency response trace.

Note how the trace is an exact copy of the original frequency response, but inverted. Also notice how the trace label shows the math function used to produce this trace.

7. Let's display both the original trace and the trace that we generated from the math function.

Press [**Disp Format**] and

press [UPPER/LOWER].

This turns on the upper/lower display format.

Press [**Active Trace**].

This selects Trace B (the lower trace) as the active trace.

Press [**Meas Data**] and

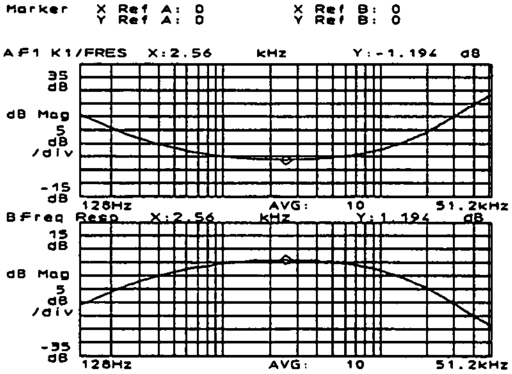
press [FREQUENCY RESPONSE].

This puts the current frequency response measurement on Trace B.

Press [**Scale**] and

press [MATCH X SCALE].

This matches the lower display to the same X-axis scaling that we used for the upper display.


Marker
X Ref A: 0
Y Ref A: 0
X Ref B: 0
Y Ref B: 0
A F1 K1/FRES X:2.56 kHz Y:-1.194 dB
35 dB
dB Mag
5 dB /div
-15 dB
128Hz
AVG: 10
51.2kHz
B Freq Resp X:2.56 kHz Y:1.194 dB
15 dB
dB Mag
5 dB /div
-35 dB
128Hz
AVG: 10
51.2kHz

8. Press [**Analys**],

   press [DEFINE FUNCTION],

   press [DEFINE F2],

   press [FUNCTION (F1–F5)],

   press [FUNCTION F1]

   press [*].

   The press [**Meas Data**],

   [FREQUENCY RESPONSE],

   [ENTER].

You've just defined Function F2.

We defined F2 as the product of Function F1 (the inverse trace we just created) and the orginal frequency response trace. The product of these two traces should be a flat line

If you did everything correctly, the resulting trace should show a flat response—however, you may not be able to see this is autoscaling is not turned on.

9. Press [**Meas Data**],

   press [MORE],

   press [MATH FUNCTION],

   press [F2].

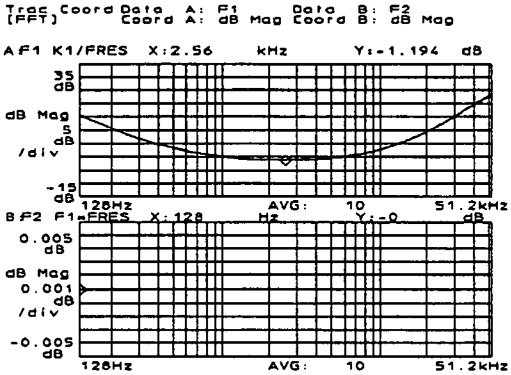
   Then press [**Scale**] and

   toggle to [AUTOSCALE **ON** OFF].

   If the X-axis scale is not logarithmic,

   press [**Trace Coord**] and

   toggle to [X-AXIS LIN **LOG**].



Note how the product of the inverse trace and the orignal frequency response trace is a flat line.

Math Task 2: Performing a Math Operation

Task Overview

This task shows how to use a math operation to modify a trace—in this example, we're going to integrate a flat line, converting it to a sloping line.

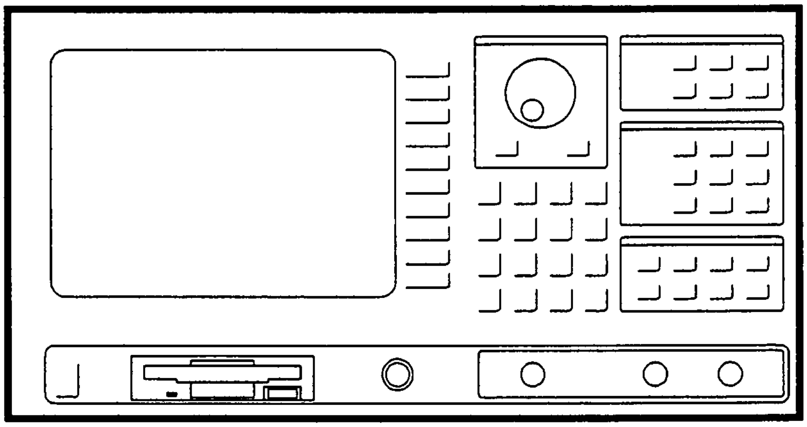
What you will need:

- You do not need any external devices or cables for this task.

What you will do:

- Display a constant (in this case, a constant equal to 1) and then integrate that constant to form a sloping trace.

Task Setup



The Task

1. Press [**Preset**] and

   press [DO PRESET].

2. Press [**Analys**],

   Press [DEFINE FUNCTION] and

   press [DEFINE F1].

In a moment, we're going to define the math function that integrates constant K1. But first, let's look at constant K1. To look at it, we must define a function to be equal to constant K1.

3. Press [CONSTANT (K1–K5)],

   press [CONSTANT K1],

   press [ENTER]

This sets function F1 to be equal to constant K1. We can't display a constant unless we assign it to a math function.

4. Press [DEFINE F2],

   press [OPERATION],

   press [MORE],

   press [INTEG( ],

   press [CONSTANT (K1–K5)],

   press [CONSTANT K1],

   press [ )],

   press [ENTER]

We've just created math function F2. This function takes constant K1 (which is set to 1) and integrates this value.

5. Let's display both the original trace and the trace that we generated from the math function.

   Press [**Disp Format**] and

   press [UPPER/LOWER].

   In a moment, we're going to put function F1 on the upper trace and function F2 on the lower trace.

6. Press [**Meas Data**],

   press [MORE],

   press [MATH FUNCTION],

   press [F1].

   This displays function F1. At this point, you probably won't be able to see it very well since the display scaling must be adjusted.

7. Press [**Scale**] and

   toggle to [AUTOSCALE **ON** OFF].

   This shows a flat line—this is a visual representation of constant K1.

8. Press [**Active Trace**].

   Press [**Meas Data**],

   press [MORE],

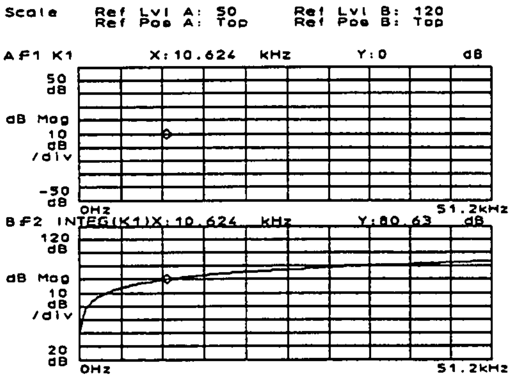
   press [MATH FUNCTION],

   press [F2].

   This displays function F2 on the lower trace. At this point, you probably won't be able to see it very well since the display scaling must be adjusted.

9. Press [**Scale**] and

   toggle to [AUTOSCALE **ON** OFF].



Scale Ref Lvl A: 50 Ref Lvl B: 120
Ref Pos A: Top Ref Pos B: Top

A F1 K1
X: 10.624 kHz
Y: 0
dB
50 dB
dB Mag
10 dB /div
-50 dB
0Hz
51.2kHz
B F2 INTEG(K1)X: 10.624 kHz
Y: 80.63
dB
120 dB
dB Mag
10 dB /div
20 dB
0Hz
51.2kHz

This shows the integrated function. The curve appears to be exponential because the analyzer's default trace coordinate is dB magnitude. This is because in dB magnitude, the Y-axis is logarithmic.

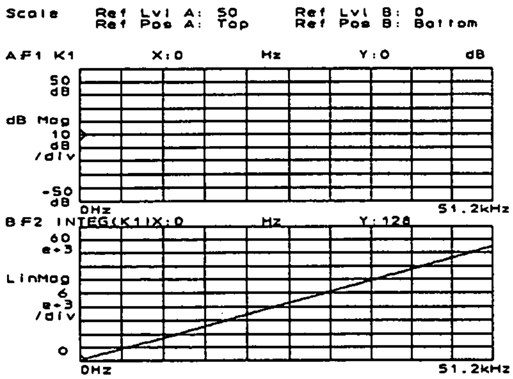
For most measurement situations, a logarithmic Y-axis is preferable—but for this example, we need to change to a linear Y-axis.

10. Press [**Trace Coord**] and

    press [LINEAR MAGNITUDE].

    Now press [**Scale**] and

    toggle to [AUTOSCALE **ON** OFF].



Scale Ref Lvl A: 50 Ref Lvl B: 0
Ref Pos A: Top Ref Pos B: Bottom

A F1 K1
X: 0
Hz
Y: 0
dB
50 dB
dB Mag
10 dB /div
-50 dB
0Hz
51.2kHz
B F2 INTEG(K1)X: 0
Hz
Y: 128
60 e-3
LinMag
6 e-3 /div
0
0Hz
51.2kHz

This displays function F2 on a linear Y-axis scale.

Because function F1 is equal to 1 (and is therefore a flat line) it appears the same whether it's displayed with a linear or a dB magnitude Y-axis. However, if you want to display F1 with linear magnitude scaling, go to the next step.

11. Press [**Active Trace**],

    press [**Trace Coord**],

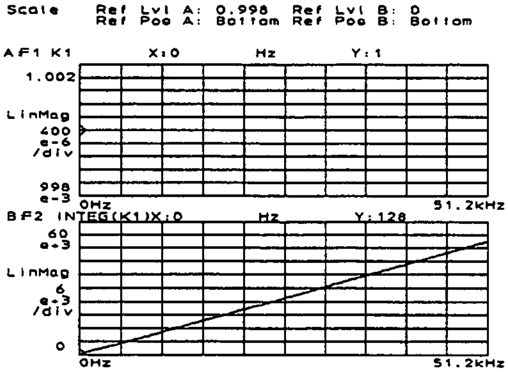
    press [LINEAR MAGNITUDE].

At this point, you will have to autoscale again.

Now press [**Scale**] and

toggle to [AUTOSCALE **ON** OFF].

In this step, you changed the trace coordinate of the upper trace from dB magnitude to linear magnitude. Now both upper and lower traces have the same Y-axis scaling.



Scale Ref Lvl A: 0.998 Ref Lvl B: 0
Ref Pos A: Bottom Ref Pos B: Bottom

AF1 K1
X:0
Hz
Y:1
1.002
LinMag
400 e-6 /div
998 e-3
0Hz
51.2kHz
BF2 INTEG(K1)X:0
Hz
Y:128
60 e-3
LinMag
6 e-3 /div
0
0Hz
51.2kHz

Chapter 10

Chapter 10

Plotting and Printing Measurement Results

Plotting and Printing Measurement Results

Introduction

This chapter contains two tasks that provide a brief overview of plotting and printing procedures. You can use a variety of HP-IB plotters or printers to show measurement results. Contact your local Hewlett-Packard Sales/Service Office for a listing of currently-supported peripheral devices.

It's important to remember that you can plot or print two different ways—either to a device on the HP-IB or to the analyzer's internal disk drive. If you do not have the analyzer connected to the HP-IB, you can simply plot or print to the analyzer's internal disk and then take this 3.5-inch flexible disk to another location and plot or print from there.

Note

Before you plot or print to the analyzer's internal disk, make sure you've formatted a 3.5-inch flexible disk and selected the format type you want (either LIF or DOS). For example, if you plot or print to a LIF-formatted disk, you won't be able to read this disk on a system that expects a DOS-formatted disk. To learn more about formatting an internal disk with the HP 35665A, see chapter 11.

Task 1: Plotter Setup

1. Connect the plotter to the analyzer's HP-IB connector.

   The HP-IB connector is on the analyzer's rear panel.

2. Press [**Local/HP-IB**].

   Press [SYSTEM CONTROLLR].

   This sets the analyzer to be the system controller. The analyzer must have control of the HP-IB bus to plot (or print) anything.

   This procedure assumes that the analyzer is the only controller on the HP-IB. If you have more than one controller, see the *HP-IB Programming with the HP 35665A*.

3. Determine the HP-IB address of the plotter.

   You may need to refer to the operating guide for your particular plotter. *Make sure all external devices on the HP-IB have a unique address.*

4. Press [PLOTTER ADDRESS].

   Now enter the appropriate address, using the numeric keypad. Afterwards, press [ENTER].

   The address you enter is retained even if you turn off the analyzer's power.

5. Press [**Plot/Print**].

   If you do not want a page eject (form feed) after each plot, press [MORE SETUP] and toggle to [PAGE EJCT ON **OFF**].

   If you do not want a time stamp on each plot, press [MORE SETUP] and toggle to [TIME STAMP ON **OFF**].

   The default settings are that both page eject and time stamp are on, so you don't have to do this step before plotting.

   To set the format of the time stamp, press [**System Utility**], [CLOCK SETUP], and [TIMESTAMP SETUP].

6. Press [RETURN] or [PLOT/PRINT]. Then press [PLOT PEN SETUP].

   This shows the current assignments for each plotter pen. If you need to change a pen, press an appropriate softkey. Then using the numeric keypad, enter the number of the pen you want assigned to that particular part of the plot. Afterwards, press [ENTER].

   If you want to change all the pen assignments to the analyzer's default assignments, press [DEFAULT PENS].

The analyzer lets you assign pens numbered 0 through 16. Check to make sure your plotter can accommodate the pens assignments you have made.

If you select pen 0, nothing will be plotted for that pen (this lets you delete part of a trace when it's plotted). Also, if you specify a pen number that does not exist for your plotter, nothing will be plotted for that pen.

You can also specify how you want Trace A or Trace B to look on the plotted page. For example, if you press [TRACE A LINE TYPE], you can select a solid, dotted, or dashed line.

You can also select a user-defined line for Trace A or Trace B. To specify this, press [USER LINE TYPE] and enter a number from –6 to 6. See your plotter documentation for more details.

7. If you need to set the plotter speed, press [RETURN].

   Then press [MORE SETUP] and [PLOT PEN SPEEDS].

   Press either [FAST (50 cm/s)] or [SLOW (10 cm/s)] to specify a pen speed appropriate for your plotter.

Make sure the speed you select is appropriate for both your plotter and your choice of plotter pen.

Task 2: Printer Setup

1. Connect the printer to the analyzer's HP-IB connector.

   The HP-IB connector is on the analyzer's rear panel.

2. Press [**Local/HP-IB**].

   Press [SYSTEM CONTROLLR].

   This sets the analyzer to be the system controller. The analyzer must have control of the HP-IB bus to print (or plot) anything.

   This procedure assumes that the analyzer is the only controller on the HP-IB. If you have more than one controller, see the *HP-IB Programming with the HP 35665A.*

3. Determine the HP-IB address of the printer.

   You may need to refer to the operating guide for your particular printer. *Make sure all external devices on the HP-IB have a unique address.*

4. Press [PRINTER ADDRESS].

   Now enter the appropriate address, using the numeric keypad.

   Afterwards, press [ENTER].

   The address you entered will be retained even if you turn off the analyzer's power.

5. Press [**Plot/Print**].

   If you do not want a page eject (form feed) after each printed page, press [MORE SETUP] and toggle to [PAGE EJCT ON **OFF**].

   If you do not want a time stamp on each printed page, press [MORE SETUP] and toggle to [TIME STAMP ON **OFF**].

The default settings are that both page eject and time stamp are on, so you don't have to do this step before printing.

To set the format of the time stamp, press [**System Utility**], [CLOCK SETUP], and [TIMESTAMP SETUP].

Task 3: Selecting a Plot/Print Destination

1. Press [**Plot/Print**].

   If you're plotting or printing to a device on the HP-IB, make sure you've already pressed [MORE SETUP] and toggled to [OUTPUT TO **HP-IB** FILE].

   Then go to step 3.

2. If you're plotting or printing to a file on the analyzer's internal disk, press [**Disk Utility**].

   Press [DEFAULT DISK] and

   press [INTERNAL DISK].

   This ensures that the analyzer's internal disk drive is set to be the default disk.

   You can plot or print to any disk—we chose the internal disk for this example.

   Now press [**Plot/Print**],

   This tells the analyzer that you want to print to a file on a disk, not to a device on the HP-IB.

   [MORE SETUP], and

   toggle to [OUTPUT TO HP-IB **FILE**].

   This distinction between plotting or printing to an HP-IB device or to a file is important. When you plot or print over the HP-IB, you don't have to specify a filename. But when you plot or print to the analyer's internal disk, you must use an appropriate filename.

   Press [RETURN] then press [OUTPUT FILENAME]. Using the numeric keypad and alpha keys (or an external keyboard), enter an appropriate filename for your plot or print file.

   Afterwards, press [ENTER].

   When plotting or printing to a file, make sure you specify a new filename after each plot or print operation—unless you want the analyzer to overwrite the previous file. Also, make sure you've formatted a 3.5-inch flexible disk and selected the format type you want (either LIF or DOS). For example, if you plot or print to a LIF-formatted disk, you won't be able to read this disk on a system that expects a DOS-formatted disk. To learn how to format a disk with the HP 35665A, see chapter 11.

3. If you're plotting to an HP-IB plotter (or saving a plot file to disk), make sure you've pressed [MORE SETUP] and toggled to [DEVICE IS **PLOT** PRINT].

   If you're printing to an HP-IB printer (or saving a print file to disk), make sure you've pressed [MORE SETUP] and toggled to [DEVICE IS PLOT **PRINT**].

If you are using a DOS-formatted disk, it takes much longer to save a print file to disk than it does to save a plot file.

Task 4: Plotting or Printing

1. Check to see if the plotter/printer is ready.

Make sure the plotter/printer is turned on, has paper, and is ON LINE.

2. Press [**Plot/Print**].

   Then press

   [START PLOT/PRNT].

   If you're plotting or printing to a disk, make sure you've selected an appropriate filename (see task 3).

You should know that softkey labels do not appear on the plotted or printed results.

If the "Plot/Print device not present" message appears, you need to:

- Check the connection between the analyzer and the plotter/printer
- Make sure that you have the correct address entered for the plotter/printer
- Make sure there are no other controllers on the HP-IB

3. If necessary, press [ABORT PLOT/PRNT].

This aborts the current plot or print in progress.

When plotting or printing, the analyzer does not respond to any key presses, with the exception of the [ABORT PLOT/PRNT] softkey.

Chapter 11

Saving, Recalling, and Copying Files

11

Saving, Recalling, and Copying Files

Introduction

This chapter contains several tasks that provide a brief overview of save, recall, and copy operations. Although the sample save and recall operations shown here demonstrate how to save and recall a trace, you can save and recall setup states, limits, math, and other measurement data in much the same way.

For more information about individual softkeys, consult the *HP 35665A Operator's Reference*.

Overview

The analyzer lets you save (and later recall) the following:

- Measurement data, including traces, captured data, and waterfall data.
- Instrument setup states.
- Limits.
- Math (current definitions of all five trace math functions and constants).
- HP Instrument BASIC programs.
- Curve fit tables.
- Synthesis tables.

Selecting a Disk

You can save, recall, or copy to one of four disks:

- The analyzer's internal disk (this accepts standard 3.5-inch flexible disks).
- The analyzer's internal volatile RAM disk (for fast, temporary storage).
- The analyzer's internal non-volatile RAM disk (for fast, permanent storage).
- An external disk drive on the HP–IB.

Note

If you're using an external disk, be sure to specify its HP–IB address and its disk unit number. To do this, press [**Local/HP-IB**], press either [DISK ADDRESS] or [DISK UNIT], and enter the appropriate information.

Disk Specifier Prefix and Filenames

Before doing any save or recall operations, make sure you've selected the correct disk. Unless you've used a disk specifier prefix (such as INT: for internal disk), the save/recall operation will use the currently-selected disk.

Here are the disk specifiers:

- NVRAM: for the non-volatile RAM disk
- RAM: for the volatile RAM disk
- INT: for the internal disk
- EXT: for an external disk on the HP–IB.

After entering the appropriate disk specifier prefix, you can use the knob, numeric keypad, and alpha keys (or an external keyboard) to enter a filename. The filename you use must have no more than ten characters. Also, all characters must be printable.

Note

Files stored in the volatile RAM disk are temporary and will be lost when you turn off the analyzer. Use the analyzer's non-volatile RAM disk or internal disk drive for permanent storage.

Data Registers

In addition to storing on a disk, you can also save an individual trace to one of eight *data registers*. Each data register hold a complete trace that you have saved from the current measurement or recalled from a disk.

You must use a data register to recall a stored trace. To view a stored trace, you simply recall it into a data register and then select this data register for display. To display the contents of a data register, press [**Meas Data**] and use the appropriate softkeys in this menu to look at the data register.

You can also use a data register as an operand in a math function. In fact, using a system of data registers makes it particularly easy to use trace data as part of a math function.

Caution

Data registers are provided exclusively for intermediate storage of trace data. Traces that you store in a data register are lost when you turn off the analyzer.

Task 1: Selecting the Default Disk

1. Press [**Save/Recall**] and

   press [DEFAULT DISK].

   This calls up a menu that lets you designate the default disk.

   The *default* disk is the currently-active disk, and is therefore the destination for all save and recall operations—unless you use a different disk specifier prefix when entering a filename.

   The [DEFAULT DISK] softkey is also available from the [**Disk Utility**] menu.

2. Press [NON-VOL RAM DISK] or

   press [VOLATILE RAM DISK] or

   press [VOLATILE RAM DISK] or

   press [INTERNAL DISK].

   You can choose either of these disks as the default disk.

   If you choose the internal or external disk, you'll have to format a blank disk before you can use it. We'll show you how in the next task.

3. Press [RETURN].

   This returns you to the previous menu.

4. Toggle to [CATALOG **ON** OFF] to view the contents of the default disk.

   This displays the contents of the disk drive.

   If you are using the internal disk, you must first insert a formatted disk into the analyzer's internal disk drive (to learn how to do this, see Task 2).

   To remove the catalog, toggle to [CATALOG ON **OFF**].

Task 2: Formatting a Blank Disk

1. Make sure the disk you're going to format is *not* write-protected.

The write-protect tab should be covering the square hole at the lower-left hand corner of the flexible disk.

2. Insert the disk into the analyzer's internal disk drive.

Note the eject button. To avoid damaging the disk, do not eject it when the "busy" light is on.

3. Press [**Disk Utility**] and

   press [FORMAT DISK].

You are about to format a new disk.

4. For now, ignore the [INTRLEAVE FACTOR] softkey.

The interleave factor is the spacing between sectors on a disk. Setting the interleave factor lets you maximize the efficiency of disk operations. Although setting the most efficient interleave factor is not critical for smaller files, it will save lots of time when reading or writing very large files.

The default value is 1 (for LIF-formatted disks) or 3 (for DOS-formatted disks). To learn more about the interleave factor, see the *HP 35665A Operator's Reference.*

5. If you want to format this disk with the LIF format, toggle to [DISK TYPE **LIF** DOS].

   If you want to format this disk with the DOS format, toggle to [DISK TYPE LIF **DOS**].

Make sure you know what type of disk format you need—either LIF or DOS. For example, if you plot or print to a LIF-formatted disk, you won't be able to read this disk on a system that expects a DOS-formatted disk.

6. Make sure you really want to format this disk.

Formatting a disk destroys any information previously written to the disk. If you really don't want to format this disk, press [RETURN] (or any hardkey) to exit this menu.

Pressing [ABORT] after formatting has begun will *not* prevent loss of data.

By the way, formatting the analyzer's non-volatile RAM disk is a convenient way to "secure" the instrument—in other words, destroy confidential data—if you have information on this disk that you want to destroy after using the analyzer (information on the analyzer's volatile RAM disk is automatically erased when you turn off the analayzer's power). To format the non-volatile RAM disk, use the "NVRAM:" prefix when specifying the disk to be formatted.

7. Press [PERFORM FORMAT].

INT: should appear at the top of the screen (this indicates that the analyzer's internal disk is the default drive).

If RAM: or NVRAM: or EXT: appears, you haven't selected the internal disk as the default disk. You can either press [CLEAR ENTRY] and enter INT: with the alpha keys, or you can press [RETURN], [DEFAULT DISK], and then select the internal disk as the default disk.

8. When INT: appears at the top of the screen,

press [ENTER].

This starts the formatting operation.

If you want to format another disk—for example, the analyzer's non-volatile or volatile RAM disks, use the appropriate prefix when specifying the disk to be formatted. You can enter this information after pressing the [PERFORM FORMAT] softkey. Don't forget to include the colon after the prefix.

Formatting is not required for the analyzer's internal RAM disks, but is allowed. To learn more about disk formatting and available formats, see the *HP 35665A Operator's Reference*.

- *NVRAM:* specifies the non-volatile RAM disk
- *RAM:* specifies the volatile RAM disk
- *INT:* specifies the internal disk drive
- *EXT:* specifies an external disk

Task 3: Saving a Trace

This task demonstrates how to save a trace—however, saving setup states, limits, math functions, or other data is very similar.

1. Press [**Save/Recall**],

   press [SAVE DATA],

   press [SAVE TRACE].

If you have more than one trace displayed, make sure the trace you want to save is the active trace. *The active trace is the one with the highlighted trace label.*

2. Press [INTO FILE].

You are about to save a trace into a file on the default disk.

The [INTO D1] through [INTO D8] softkeys are used to save traces into a data register.

In addition to storing on a disk, you can also save an individual trace to one of eight *data registers*. Data registers are dedicated spaces in the analyzer's volatile RAM disk, and are provided exclusively for intermediate storage of trace data.

When recalling a trace, you simply recall it into a data register and then select this data register for display. This system makes it easy to use trace data as part of a math function. To learn more about math functions and data registers, see the *HP 35665A Operator's Reference.*

3. Using the knob, numeric keypad, and alpha keys (or an external keyboard), enter a name for the stored trace.

   Afterwards, press [ENTER].

   If you are saving to one of the analyzer's internal RAM disks, the save operation occurs very quickly—so quickly, in fact, that you may not think you've saved the data. If a different softkey menu appears, the save operation did occur.

When the analyzer prompts you for a name—a filename, for example—it automatically switches to alpha entry mode.

In alpha entry mode, the analyzer shifts certain hardkeys to alpha entry keys (note the alpha characters engraved on the front panel below these hardkeys). You can also specify uppercase or lowercase letters, using the [UPPERCASE lowercase] softkey.

If you make a mistake, you can use the appropriate edit softkeys to fix the name. You can also use the knob to help you edit.

To use the default filename ("TRACE.DAT" in this case), simply press [ENTER].

If you have an external keyboard connected, you can use it to enter a trace title without having to use the analyzer's alpha keys.

Task 4: Recalling a Trace

This task demonstrates how to recall a trace—however, recalling setup states, limits, math functions, or other data is very similar.

1. Press [**Save/Recall**] and

   press [RECALL DATA]

   press [RECALL TRACE].

You are about to recall a stored trace into a *data register.* You must first load the trace data into a data register before you can view it (or use the trace data in a math function).

2. Press [FROM FILE INTO D1].

   Then use the knob, the numeric keypad, and alpha keys (or an external keyboard) to enter a name for the stored trace.

   Afterwards, press [ENTER].

This recalls the stored trace into data register D1.

3. Press [**Meas Data**],

   press [MORE],

   press [DATA REGISTER],

   press [D1].

This lets you view the contents of data register D1.

Once you've loaded trace data into a data register, you must select this data register for viewing by pressing [**Meas Data**] and using the softkeys in this menu to select the appropriate data register.

Math functions, data registers, and waterfall registers can only be viewed by selecting them for display under the [**Meas Data**] menu.

Task 5: Copying a Disk

This procedure shows how to copy the contents of one 3.5-inch flexible disk to another flexible disk, using the analyzer's RAM disk as intermediate storage. After completing this task, you can use similar procedures to do related operations (for example, copying one of the analyzer's internal RAM disks to the internal disk drive).

Keep in mind that the analyzer cannot copy DOS-formatted files to a LIF-formatted disk, or vice-versa. The analyzer displays an error message if you try to do this.

1. Press [**Disk Utility**] and

   press [COPY ALL FILES].

   If you don't want to copy all files, use the procedures shown in task 6 (later in this chapter).

2. Press [SOURCE DISK].

   Make sure the INT: specifier prefix appears at the top of the screen—otherwise, the source disk will not be the internal disk.

   Using the knob and the alpha keys, specify INT: as the source disk.

   When the specifier is correct, press [ENTER].

   The source disk is the disk you're going to copy *from*. In this example, we're going to specify the source disk as the analyzer's internal disk drive.

   The disk specifier prefix of the default disk appears at the top of the screen. If the wrong specifier appears, select the specifier appropriate for your source disk:

   - *NVRAM:* specifies the non-volatile RAM disk
   - *RAM:* specifies the volatile RAM disk
   - *INT:* specifies the internal disk drive
   - *EXT:* specifies an external disk

   Instead of entering the correct disk specifier prefix by using the alpha keys, you can also select the prefix by using the [DEFAULT DISK] softkey (in the previous menu) to change the default disks.

3. Press [DESTIN DISK].

   The destination disk is the disk you're going to copy *to*.

   Using the knob and the alpha keys (or an external keyboard), specify RAM: as the destination disk.

   When the specifier is correct, press [ENTER].

   This specifies the destination disk as the analyzer's internal RAM disk.

4. Insert the source disk into the analyzer's internal disk drive.

   Make sure the source disk is write-protected, so you don't accidentally erase it.

   This disk is write-protected if you can see through the square hole at the lower-left hand corner of the flexible disk.

5. Press [PERFORM COPY ALL].

   Before you copy the files, you should check to see if both disks are formatted the same way. You may have trouble reading your data if you copy DOS-formatted files to a LIF-formatted disk or vice-versa.

6. You've just completed one disk copy operation.

   To copy from one 3.5-inch flexible disk to another, you must use the analyzer's RAM disk as intermediate storage. To complete this particular copy procedure, you must now copy from the RAM disk to the *other* 3.5-inch flexible disk.

7. Insert the destination disk into the analyzer's internal disk drive.

   Make sure the destination disk is *not* write-protected.

   This disk is write-protected if you can see through the square hole at the lower-left hand corner of the flexible disk.

8. Press [SOURCE DISK].

   Using the knob and the alpha keys (or an external keyboard), specify RAM: as the source disk.

   When the specifier is correct, press [ENTER].

   This specifies the source disk as the RAM disk.

9. Press [DESTIN DISK].

   Using the knob and the alpha keys (or an external keyboard), specify INT: as the destination disk.

   When the specifier is correct, press [ENTER].

   This specifies the destination disk as the analyzer's internal disk drive.

10. Press [PERFORM COPY ALL].

    This completes the procedure. You've copied the contents of one 3.5-inch flexible disk to another 3.5-inch disk.

Task 6: Copying a file

This task shows how to copy a trace file from one disk to another. Although the task shown here demonstrates how to copy a trace file from the analyzer's volatile RAM disk to the analyzer's internal 3.5-inch flexible disk, copying from or to the NVRAM disk and internal disk is done the same way. You can also use this procedure to copy individual setup states, limits, math functions, or other data.

1. Press [**Save/Recall**] and

   press [DEFAULT DISK].

   As we mentioned earlier, the *default* disk is the currently-active disk, and is therefore the destination for all save and recall operations—unless you use a different disk specifier prefix when entering a filename.

2. Press [VOLATILE RAM DISK].

   In this example, we've used the analyzer's volatile RAM disk. If we wanted to copy a file from the analyzer's non-volatile RAM disk or from the internal disk, we could select either the non-volatile RAM disk or the internal disk as the default disk.

3. Press [RETURN].

   This returns you to the previous menu.

4. Toggle to [CATALOG **ON** OFF] to view the contents of the default disk.

   Turning on the catalog makes it much easier to select the source file.

   The analyzer will display the contents of the default disk.

   Turning on the catalog makes it much easier to select the source file.

5. If there is more than one file in the catalog listing, use the knob to highlight the file that you want copied.

   If you're using an external keyboard, you can use the left/right arrow keys to scroll through a file catalog.

When you have a catalog listing displayed, the analyzer uses the name of the highlighted file as the default file name. This saves you the trouble of entering the name with the alpha shift keys.

6. Press [COPY FILE],

   press [SOURCE FILENAME],

   press [ENTER].

   Notice how the analyzer used the highlighted file as the source filename.

Notice how the analyzer used the highlighted file as the source filename. This makes it easier to select a file, since you don't have to use the numeric keypad and alpha keys (or external keyboard) to specify the file you want copied—though of course, you *can* specify it this way if you want to.

10. Press [DESTIN FILENAME].

    Then use the knob, numeric keypad, and alpha keys (or an external keyboard) *to add the disk specifier for the destination disk.*

    Then press [ENTER].

For example, you can keep the original filename but add the "INT:" prefix—this is necessary for most copy operations since the destination disk is usually not the current default disk.

If you want to copy a file to the same disk—for example, to form a duplicate file on the same disk—you don't need a disk specifier. However, you must use a different destination filename. The analyzer does not allow duplicate filenames.

Don't forget to use a colon between the disk specifier and the filename. Use the appropriate [MORECHARS] softkey to add the colon.

- *NVRAM:* specifies the non-volatile RAM disk
- *RAM:* specifies the volatile RAM disk
- *INT:* specifies the internal disk drive
- *EXT:* specifies an external disk drive

11. Press [PERFORM FILE COPY].

This performs the file copy operation.

12. Press [RETURN] and

    press [DEFAULT DISK].

    If you turned off the catalog, toggle to [CATALOG **ON** OFF] to see if you successfully copied your source file to the destination disk.

This lets you view the contents of the default disk. If the copy operation was successful, you should see your newly-created file in the catalog listing.

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